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THE RELATIONS BETWEEN THE MIND AND THE NERVOUS SYSTEM.*

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IN order that one person may know what another person is talking about, there must be an agreement in regard to the meaning of the terms employed. Without this there can be no common ground on which those engaged in a discussion as speakers and listeners can stand. For it is obvious that if by a word one of the disputants means one thing and another by the same word means quite another thing, they will both talk of different things, and that hence their statements and arguments will be worse than useless, for they will not only have been of no avail in convincing an adversary or in instructing a pupil, but they will in all probability have been potent agencies in stirring up the bad blood that so often shows itself where, least of all, it ought to appear—in efforts to arrive at the truth.

It is especially necessary that there should be no misunderstanding in regard to one's terminology when we come to discuss those subjects in regard to which our knowledge is not full and precise, and which, consequently, have been studied from different stand-points by different inquirers, and by the light that their own minds have thrown upon them rather than by that of other minds. Suppose, for instance, that a doctor of music should go into the turpentine-regions of North Carolina to give a lecture on "pitch" to the dwellers in the pine-forests, and should talk of the elevation of the voice or of an instrument—is it not quite within the range of probability that some one of the audience would rise in indignation and tell the learned gentleman that he did not know what he was talking about, and that every man, woman, and

* An address delivered at the Lehigh University, on "Founder's Day," October 9, 1884.

child in the State knew that pitch was a "thick, black, sticky substance obtained by boiling down tar," and not only that, but he and the greater part of those present would feel as though their attendance had been obtained by false pretenses, and that the money they had paid for admission should be returned to them?

Or, if I should go out among the sturdy farmers of Northampton County and gather them together to hear a lecture on "ducks," and should confine my remarks to pets and darlings of the female part of the human species, is it not very certain that though the young agriculturists in search of wives would listen with eagerness to what I had to say (and it would be interesting, I think), the more sedate would feel as though I had played them a trick? Neither the young nor the old would have got what they came for, and yet there would be ample authority for the meaning given to the word.

And when I come before an educated assemblage such as this, composed to a great extent of persons of both sexes, who have been in the habit of thinking deeply on subjects of vast importance, and who have formed clear ideas of what meanings are to be given to the words they meet in their studies or use in their conversation, it is indispensable that if I wish to make myself understood and to speak with that force so essential in obtaining assent, I should do all in my power to avoid ambiguity of signification.

It would be very easy to bring before you many subjects in regard to which you have your own ideas, formed after much study and reflection, and to which, therefore, you would have a right to cling, and I should be obliged to start out by attempting to define accurately the terms to be employed. I doubt, however, if it would be possible to select one in which such a course would be more necessary than in that of which I am to speak to-day. The word "mind" is a little one, but it means a great deal, and if we strive for accuracy, as of course we should do, it means a great many different things. In fact, it is probable that, were I to send a canvasser among you, I should receive a hundred different explanations of the term, and nowhere would the variations be more numerous or more transcendental than among the eminent gentlemen—president, professors, and trustees—who constitute the governing body of this university; for I think I have observed that, the higher we go in mental development, the more numerous and refined are the differences as to what the mind is. No two metaphysicians ever yet exactly agreed in regard to the signification to be attached to the word mind.

But, before explaining to you my understanding of the term, it is necessary, in order to avoid all ground for misconception, to tell you what I do *not* mean. I do not mean the soul, although it and the mind are by a large and influential class of philosophers regarded as constituting one essence—as being, in fact, identical. With it, however, I conceive that we have nothing to do, so far as science goes. Its very

existence is a matter of faith in which, probably, most of us believe, but which is altogether beyond the limits of proof, or even of investigation. There is nothing tangible about it. We should not know how to proceed to ascertain the existence of the soul. No one could go into a court of justice and demonstrate by the rules of evidence that he himself, or his neighbor, has, as an integral part of his organization, a never-dying principle responsible to God for the deeds done in the body. He could not say that life is the soul, for, if he did, he would have to accord souls to all living beings, vegetables as well as animals. And, if he were to declare that the mind and the soul are identical, he would be obliged to admit that the "beasts that perish," and even the vine that creeps up the side of his house and finds out where the supports are situated around which it sends out its tendrils, have souls which, if not as perfect as his own, are none the less real. No, his belief in the existence of his soul rests upon higher principles than those that govern earthly tribunals or scientific investigation. He believes through the faith that is in him, not through the impressions that have reached his central nervous organs through his eyes or ears or nostrils or tongue or fingers—the only mediums by which actual knowledge can be obtained.

But with the mind it is very different. Its existence, its powers, its aberrations, are proved in courts every day, and we are constantly demonstrating its reality in our physiological and pathological laboratories, and in our hospitals and in the practice of our physicians. In fact, it is being shown every instant, in the person of every man, woman, and child, and in every living being throughout the earth, that mind exists and is a power. We see it exhibited in all its varieties. We are all of us familiar with good and bad minds, and some of us see human beings with minds so degraded and undeveloped that they are lower, so far as regards intelligence, than dogs or canary-birds. They do not know enough to reach out their hands and take the food that is placed before them, whereas we have all seen canary-birds haul up with their beaks whenever they were hungry the little wagons of seed on the outside of their cages.

But, though the minds of these poor beings are many of them inferior to those of our domestic animals, it would be presumption in us to say that the soul of the veriest idiot that breathes is not as pure and as high in the scale of souls as that of a Plato or a Newton. If the mind and the soul are identical, all those predisposing causes inherent in the parents, and which are capable of causing imbecility and idiocy in the offspring, are also capable of damaging the immortal soul that we believe God has given to every human being. The little piece of bone of a fractured skull that, pressing upon the brain, stupefies the mind, at the same time damages the soul; the congestion or inflammation of the brain that converts a man of giant intellect into a maniac or a dement beyond the hope of cure, also irreparably ruins

the soul, which, we are told, never dies, and which, if it exists, is doubtless far removed from the influence of bodily diseases or injuries.

Therefore I beg you to understand that what I have to say relates solely to the mind. Your souls are, doubtless, cared for by those whose qualifications for instructing you in their management are greater than any that I can claim.

Now, what is mind? Those of you who have thought much upon the subject will not be surprised when I say that I do not know. There may be others, however, who, though too polite to say so, may think it a piece of impertinence for me to come here to speak of something of the nature of which I am obliged at the very beginning of my discourse to confess my ignorance. But, if they thought thus, they would be doing me great injustice, and it would be easy for me to retaliate by asking them what a piece of wood is. Could they tell? Does any one know? Does any one know what anything is? There are sixty-four elementary bodies of which the earth is composed, but does any one know what a single one of them is? Take one with which you may be presumed to be especially familiar—iron. What is it? You do not know. You can describe it to me. You can point out its properties. You can tell me where it comes from. Yes, and I can do the same with the mind. I can tell you where it comes from, describe its properties, point out its manifestations, and you will recognize mind as clearly as I should recognize the iron, the qualities of which you should portray; but, as to telling you what mind is, I can not do it any more than you can tell me what iron is.

Some of you are students of physics. If you were to present yourselves in the class-room and ask your distinguished professor of that branch of science to tell you what heat, light, electricity, magnetism are, he would be obliged to tell you that he does not know, just as I am forced to tell you that I do not know what mind is. But, though he is ignorant of their essential natures, think of the vast fields of knowledge he is able to open up to you by putting you in possession of what is known of these forces!

Go into the chemical laboratory of your own noble university—in honor of whose founder we are here to-day—and touch the two poles of a galvanic battery. What is it that thrills through your bodies, and perhaps even burns the skin of your fingers; or, even, if the current be strong enough, strikes you dead on the instant? Galvanism. What is galvanism? A force. Yes, and so is light a force, and heat, and gravitation. But, when I am told this, I am just as far from knowing what any one of the forces is as I was before. All that you could do, if I persisted in asking for a fuller explanation, would be to tell me something of the origin and properties of the force in question, and in this way I should obtain some idea of its characteristics, and should be in no danger of mistaking it for any other force. That is what your Professor of Physics does for you,

and, if you have only profited by the instruction you have received, you have a store of facts at your command that will enable you to recognize heat, light, electricity, gravitation, magnetism, whenever you see them manifested. When, therefore, you ask me what mind is, I answer that it is a force possessing peculiar properties, and developed by a substance constituting a part of the nervous organism of man and other animals, and known to anatomists and physiologists as gray nerve-tissue. This is similar in all essential respects, so far as its terms are concerned, to the definition that you would give me of any other force. Of course, it can be made more precise and extensive, but no enlargement would change its character.

The gray nerve-tissue exists in the form of aggregations of minute cells in various parts of the nervous system. In man, by far the largest collections are found in the brain, and especially on the outside of it, covering it as the rind covers an orange, and hence called the cortex, or the cortical substance. Besides this large mass, spread out to the thickness of the twelfth of an inch or more over the exterior of the brain, there are masses of gray nerve-tissue in other parts, varying in size from that of a walnut to that of a small pea. In this diagram the situations of the masses of gray tissue existing in the brain are shown. You will observe a very beautiful arrangement for increasing the extent of the cortical substance without at the same time increasing the size of the brain, and thus making it heavier than it would be comfortable to carry. The surface is convoluted, and the gray matter, following the convolutions, is hence doubled over and over again on itself. If the cortex were spread out smoothly, like the skin on an apple, it would cover a body more than four times the size of the average human brain. We should, then, in order to get as much mind-producing substance as we have now, require heads four times the volume of those that we now carry on our shoulders. Gray nerve-tissue is found also in the spinal cord, and some animals, as the frog and the alligator, have more of it in this organ than they have in the brain. It also exists in connection with what is called the sympathetic nerve, in the form of masses called ganglia, and generally placed in intimate relation with the several vital organs of the body—as the heart, stomach, lungs, liver, etc.

Besides the gray nerve-tissue, there is another kind of nerve-substance called the white, and which, instead of consisting of granular forms or cells, is made up of tubes or fibers. The white nerve-substance has nothing to do with the evolution of nerve-force or mind. Its office is to transmit the nerve-force from the places where it is formed to other parts of the body. The great mass of the brain and of the spinal cord, and the whole of the nerves that ramify through the body, consist of white nerve-tissue. You will understand, therefore, that this substance is analogous to the wires of the telegraph, while the gray substance corresponds to the batteries.

And just as a particular arrangement, for instance, of zinc and carbon and sulphuric acid, leads to the evolution of galvanism, so a particular arrangement of nerve-cells leads to the evolution of the force that we call mind. We can not explain why or how the galvanism comes from the zinc, carbon, and sulphuric acid; neither can we tell why or how mind comes from the nerve-cells. Both are ultimate facts beyond which we can not go, and may never be enabled to go.

Now, as by their properties we recognize any of the other forces of Nature that I have mentioned, so by its properties we recognize mind. An object is perceived, and it is the mind that perceives it; an idea is formed, and it is the mind that forms it; an emotion is felt, and it is the mind that feels it; an act is willed, and it is the mind that wills it. Hence, there are these four groups of mental faculties, to one of which every possible manifestation of mind belongs—perception, intellect, emotion, and will.

The many interesting points concerned with these categories of mental faculties do not come within the scope of the present remarks, the chief object of which is to discuss the subject of the relations existing between the mind and the nervous system.

In the very earliest times of which we have any record, and even at the present day among barbarous nations, the idea existed that the brain was not the only organ concerned in the production of mind. Thus, the emotions were, many of them, supposed to have their seat in the heart, the liver, the spleen, the bowels. Love, for instance, was conceived by the heart, as were also several other tender or compassionate feelings. The liver was supposed to be intimately connected with the depressing emotions, the spleen with spite or revenge, and the bowels with pity. So strongly was this idea implanted, and so universally did it prevail, that it has influenced the forms of speech among all nations that are not so low in the scale as not to have emotions. Thus we say that a person has "a good heart," the lover tells his lady-love that he "loves her with all his heart," and the sinner when he turns away from his wickedness is said to have undergone a "change of heart." The influence ascribed to the liver is shown by our expressions "melancholic," "choleric," and by one that I heard used a short time since by a man who was complaining of an insult that had been put upon him, and who said that it made "his bile flow." Then we say of a disagreeable or quarrelsome person that he is "splenetic," or that he "vents his spleen," and we speak of a pitiless person by asserting that he has "no bowels of compassion."

How could the notions that gave birth to such expressions arise in the human mind? Doubtless, the origin was due to the fact that, under the influence of certain emotions, there are disturbances in the organs with which they are associated. Thus, the passion of love produces a sensation of fullness in the region of the heart, and the action of the organ is quickened. In mental depression, or as a consequence

of fits of anger, the liver is so deranged that the bile ceases to be produced, and pain is felt in that part of the body in which the liver is situated ; and, when the emotion of pity is strongly experienced, a sensation of weakness, or, as it is sometimes called, a sinking feeling, is felt at the pit of the stomach.

It has been customary with modern writers—and I have until quite recently been of the like opinion—to regard these disturbances as being the effects of emotions that originated in the brain, and not as indicating that the organs in which they are felt have anything to do with the evolution of love or anger or fear or compassion, or any other passion or feeling. The idea has become so widely spread among educated persons that the brain is the only organ of the body that has any direct relation as a generator with the mind, that it seems like a tremendous blow at the system of existing facts to attempt to take from it any of its power. But it is only recently that physiologists and pathologists are beginning to make a thorough investigation into that great division of the nervous system consisting of the sympathetic nerves and their ganglia. If you will look at this diagram, you will obtain some idea of the situation and connections of these nerves. As you see, they are situated on each side of the spine, and are in direct connection with the brain, and their ramifications extend to every one of the vital organs situated in the chest, the abdomen, and the pelvis. These nerves differ from the other nerves—those that convey impulses to and from the brain—in the remarkable fact that they have at various parts of their course little swellings or enlargements called ganglia, and which consist of gray matter. Now, gray nerve-tissue, wherever it exists, is a generator of nerve-force, or mind, and it is not unreasonable to suppose, therefore, that these masses of the tissue in question, that are placed around the heart, the liver, the spine, and other organs, and in vast number in their substance, have some influence in causing the production of those emotions that make themselves felt in the parts of the body with which former universal beliefs and our present forms of speech have associated them. We find, too, as an additional fact in support of this view, that in certain mental affections, characterized by great emotional disturbances, these ganglia are in various parts of the body the seats of disease.

Therefore, there is some reason for the opinion that not to the brain alone do we owe the evolution of mind, but that the sympathetic system of nerves is also concerned in its production.

But there is another part of the nervous system not generally regarded as a mind-producing organ, but which I am very sure is directly concerned in the evolution of the force which so pre-eminently by its presence distinguishes organic from inorganic bodies, and that is the spinal cord.

The spinal cord is contained in the vertebral column, or, as it is popularly called, the backbone. It extends from the brain to near the

end of the trunk, and is at its thickest portion about the diameter of the end of the little finger. It contains throughout its whole length gray nerve-tissue arranged somewhat in the form of the letter H. The diagram to which I direct your attention shows the arrangement on a greatly magnified scale. More than nine years ago, in an address delivered before the New York Neurological Society, and entitled "The Brain not the Sole Organ of the Mind," I called attention to the fact that certain mental faculties are seated in the spinal cord. It will probably not be out of place if I adduce here some of the facts and arguments upon which I based that opinion, and which convince me of its correctness.

As we have just seen, all the manifestations of which the mind is capable in its fullest development are embraced in four groups—perception, the intellect, the emotions, and the will. Either one of these may be exercised independently of the others. Thus, an individual may have a perception without any intellectual, emotional, or volitional manifestation, and so the intellect, the emotions, or the will may be brought into action without the necessary participation of each other. It is, however, clearly established that all mental processes of any kind have their origin in perception, and that an individual born without the ability to perceive, either from defects in the external organs of the senses, or of the central ganglia by which impressions on these organs are converted into perceptions, would be devoid of intellect, emotion, and will—would be, in fact, lower in mental development than the most degraded types of animated beings. He would not, in fact, be able to conceive of so simple an idea as that one and one make two. How could he, unless he could see two objects, or hear two sounds, or smell two odors, or taste two flavors, or feel two tactile impressions? There would be no means by which he could differentiate one from two, for no knowledge on the subject could reach his brain. Though he might have the intellectual potentiality of Socrates, he would be an actual imbecile, without the slightest mental scintillation. The brain and other nerve-centers can only act from impressions received from without.

Perception is, therefore, the primary manifestation of mind, and is that part the office of which is to place the individual in relation with external objects. Thus an image is formed upon the retina, the optic nerve transmits the excitation to its ganglion, this at once functionates, the force called perception is evolved, and the image is perceived. If the retina be sufficiently diseased, the image is not formed; if the optic nerve is in an abnormal condition, the excitation is not transmitted; if the ganglion is disordered, the perceptive force is not evolved. Therefore, in order that a true perception may be experienced, an organ of sense, a nerve, and a mass of gray nerve-tissue are necessary, and no other organs are required.

It is rarely the case that an individual perceives an impression

made upon any one of the organs of the senses without a higher mental operation being performed. This is especially the case when the perception is of such a character as to be irritative. Thus, if an exceedingly bright light be allowed to impinge upon the retina, the brows are corrugated, and, if it be still more intense, the eyelids are closed so as to shut it out altogether ; if a very loud noise strikes upon the tympanum, the head is turned so as to prevent the undulations of the atmosphere reaching the ear in full force ; if the skin be irritated, the part is, if possible, drawn away, and, if the irritation be so great as to excite pain, the whole body is thrown into contortions and efforts are made to escape. Some of these movements appear to be involuntary, and even to be performed in direct opposition to the will, and then they are said to be reflex—that is, that they are the result of the conversion of a sensation into a motor impulse without the accompanying action of any ganglion, the action of which is the evolution of volitional force.

Now, it is very true that some of the actions in question are apparently altogether involuntary, and are thus true reflex movements, and it is no difficult matter to separate them from those other which are clearly volitional, determinate, and performed with a definite purpose in view. If, for instance, an irritative substance be applied to the interior of the nostril, the action which we call sneezing is produced. This consists of a spasmodic contraction of certain muscles by which the air in the lungs is forcibly expelled through the nostrils. It is automatic and preservative in character, the object being to get rid of the offending substance. It is always performed in the same way, the muscles brought into action are always the same, and it is spasmodic, sudden, and without deliberation or judgment, so far as we can determine from our own consciousness. Again, if the soles of the feet are tickled, they are drawn away, although it is possible for the impulse to remove them to be restrained by the exercise of the will, and, indeed, some individuals can prevent sneezing by strong volitional power evolved from the higher ganglia of the brain. But let us suppose the case of a man with a disease of the upper part of the spinal cord of such a character as to prevent its conveying volitional impulses from the brain to the muscles of the lower limbs ; now let the soles of the feet be tickled, and we shall find that they are drawn away, and generally with very much more force than when the brain is allowed to act. Such a movement is probably one of true reflex character ; it is spasmodic and indeterminate, being more extensive than is necessary. But let us go still further in our suppositions, and imagine that in such a case the mere drawing away of the foot was not sufficient to avoid the irritation, and that the individual deliberately lifted up the other foot in the attempt to remove the offending object, and that this action not proving adequate, he made two or three leaps in order to escape. What would we call these movements? Would they not be

evidence of perception and will? Would they not be movements performed with a definite purpose—the very best possible under the circumstances—to escape from the irritation, even though the brain were unconscious of them? It must be remembered that consciousness is not the necessary accompaniment of volition, as we shall presently see from examples I shall adduce; and this being the case, I can not avoid the conclusion that actions performed under the circumstances I have stated would be based upon perception and done through the power of volition.

Warm-blooded animals are for many reasons not suitable subjects for experiments such as are required in the study of the phenomena under consideration, but in some of the lower animals, as the frog, for instance, we find those conditions present which fit them for such investigations. Thus, if the entire brain be removed from a frog, the animal will continue to perform those functions which are immediately connected with the maintenance of life. The heart beats, the stomach digests, and the glands of the body continue to elaborate the several secretions proper to them. These actions are immediately due to the sympathetic system, though they soon cease if the spinal cord be materially injured. But, in addition, still more striking movements are effected—movements which are well calculated to excite astonishment in those who see them for the first time, and who have embraced the idea that all intelligence resides in the brain. For instance, if in such a frog the webs between the toes be pinched, the limb is immediately withdrawn; if the shoulder be scratched with a needle, the hind-foot of the same side is raised to remove the instrument; if the animal is held up by one leg, it struggles; if placed on its back—a position to which frogs have a great antipathy—it immediately turns over on its belly; if one foot be held firmly with a pair of forceps, the frog endeavors to draw it away; if unsuccessful, it places the other foot against the instrument and pushes firmly in the effort to remove it; still not succeeding, it writhes the body from side to side, and makes a movement forward.

All these and even more complicated motions are performed by the decapitated alligator, and in fact may be witnessed to some extent in all animals. I have repeatedly seen the headless body of the rattlesnake coil itself into a threatening attitude, and, when irritated, strike its bleeding trunk against the offending body. Upon one occasion, a teamster on the Western plains had decapitated one of these reptiles with his whip, and, while bending down to examine it more carefully, was struck by it full in the forehead; so powerful was the shock to his nervous system that he fainted and remained insensible for several minutes. According to Maine de Biran, Perrault reports that a viper whose head had been cut off moved determinedly toward its hole in the wall. I have performed a great many experiments and made numerous observations relative to the matter, and have for a number

of years taught, in my course of lectures on diseases of the mind and nervous system, the doctrine now set forth that, wherever there is gray nerve-tissue in action, there is mind. Into the detail of these experiments it is scarcely proper on this occasion to enter; suffice it to say that they all go to establish the fact that the spinal cord, after the complete removal of the brain, has the power of perception and volition, and that the actions performed are to all intents and purposes as perfect of their kind as they would be were the brain in its place.

As I have said, it is difficult to perform experiments of the kind in question on warm-blooded animals, for the hæmorrhage that results in consequence of the necessary cutting operation soon leads to the loss of life; but, for all that, we are not without information on the subject, derived from investigations of some of the higher animals. You have, most of you, seen a decapitated chicken staggering and fluttering about the barn-yard. Whence comes the force by which its movements are made, unless from other organs than the brain? This is a rough experiment that is performed every day, but in the laboratory we do it in a more careful way, and the results are still more striking.

If the brain be entirely removed from a pigeon, the bird turns its head in accordance with the motion given to a lighted candle held before its eyes; it smooths its feathers with its bill when they are ruffled; it places its head under its wing when it sleeps; it opens its eyes when a loud noise is made close to its head. Onimus removed the brain from young ducks hatched and brought up by a chicken. These ducks had never been in the water, yet when placed in a basin they immediately began to swim. Their motions in swimming were as regular as in other ducks which had lived in the water. This series of experiments shows that even the inborn instinct of animals is not solely resident in the brain.

Now, when we come to man, and observe the experiments which are constantly being made for us, both in health and disease, we can not avoid placing the spinal cord much higher as a nerve-center than it is usually placed by physiologists.

In human anencephalic monsters, or those born without a brain, we have interesting examples of the fact that the spinal cord is possessed of perception and volitional power. Syme describes one of these beings which lived for six months. Though very feeble, it had the faculty of sucking, and the several functions of the body appeared to be well performed. Its eyes clearly perceived the light, and during the night it cried if the candle was allowed to go out. After death the cranium was opened, and there was found to be an entire absence of the cerebrum, the place of which was occupied by a quantity of serous fluid contained in the arachnoid. The cerebellum and pons Varolii were present. Panizza, of Pavia, reports the case of a male

infant which lived eighteen hours. Respiration was established, but the child did not cry. Nevertheless, it was not insensible. Light impressed the eyes, for the pupils acted. A bitter juice put into the mouth was immediately rejected. Loud noises caused movements of the body. On *post-mortem* examination, there was found no vestige of either cerebrum or cerebellum, but the medulla oblongata and pons Varolii existed. There were no olfactory nerves; the optic nerves were atrophied, and the third and fourth pairs were wanting; all the other cranial nerves were present.

Ollivier d'Angers describes a monster of the female sex which lived twenty hours. It cried, and could suck and swallow. There was no brain, but the spinal cord and medulla oblongata were well developed.

Saviard relates the particulars of a case in which there were no cerebrum, cerebellum, or any other intracranial ganglion. The spinal cord began as a little red tumor on a level with the foramen magnum. Yet this being opened and shut its eyes, cried, sucked, and even ate broth. It lived four days.

Mr. Lawrence has published the details of a very interesting case in which there was no brain. But the excito-motory functions were well performed. The child moved briskly and gave evidence of feeling pain. Its breathing and temperature were natural, and it took food. Movements such as these do not afford evidence of a very high degree of intellect, but they are precisely such as are performed by all new-born infants possessed of brains. If they are not indicative of the existence of mind, we must deny this force to all human beings on their entrance into the world.

But we are not obliged to rest on the phenomena afforded by anencephalic monsters for all the evidence that the spinal cord of man is a center of perception and volition. We have only to observe the manifestations of its action which are of daily occurrence in our own persons. And in bringing them to your notice I shall quote from a little work on "Sleep and its Derangements," which I wrote a few years ago:

"If an individual engaged in reading a book allows his mind to be diverted to some other subject than that of which he is reading, he continues to see the words, which, however, make no impression on his brain, and he turns over the leaf whenever he reaches the bottom of the page, with as much regularity as though he comprehended every word he had read. He suddenly, perhaps, brings back his mind to the subject of his book, and then he finds that he has perused several pages without having received the slightest idea of their contents.

"Again, when, for instance, we are walking in the street and thinking of some engrossing circumstance, we turn the right corner and find ourselves where we intended to go, without being able to recall any of the events connected with the act of getting there."

In such instances as these—and many others might be adduced—the brain has been so occupied with a train of thought that it has taken no cognizance or superintendence of the actions of the body. The spinal cord has received the several sensorial impressions and has furnished the nervous force necessary to the performance of the various physical acts concerned in turning over the leaves, avoiding obstacles, taking the right route, and stopping in front of the right door.

All cases of what are called "absence of mind" belong to the same category. Here the brain is completely preoccupied with a subject of absorbing interest, and does not take cognizance of the events which are taking place around. An individual, for instance, is engaged in solving an abstruse mathematical problem. The whole power of the brain is taken up in this labor, and is not diverted by circumstances of minor importance. Whatever actions these circumstances may require are performed through the force originating in the spinal cord.

The phenomena of reverie are similar in some respects to those of somnambulism, to which attention will presently be directed. In this condition the mind pursues a train of reasoning often of the most fanciful character, but yet so abstract and intense that, though actions may be performed by the body, they have no relation with the current of thought, but are essentially automatic, and made in obedience to sensorial impressions which are not perceived by the brain. Thus, a person in a state of reverie will answer questions, obey commands involving a good deal of muscular action, and perform other complex acts, without disturbing the connection of his ideas. When the state of mental occupation has disappeared, there is no recollection of the acts which may have been performed. Memory resides in the brain, and can only take cognizance of those mental acts which spring from the brain, or of impressions which are made directly on the encephalon.

In the case of a person performing on the piano and at the same time carrying on a conversation, we have a most striking instance of the diverse though harmonious action of the brain and spinal cord. Here the mind is engaged with ideas, and the spinal cord directs the manipulations necessary to the proper rendering of the musical composition. A person who is not proficient in the use of this instrument can not at the same time play and converse with ease, because the spinal cord has not yet acquired a sufficient degree of automatism. Darwin gives a very striking example of the independent action of the brain and spinal cord. A young lady was playing on the piano a very difficult musical composition, which she performed with great skill and care, though she was observed to be agitated and preoccupied. When she had finished, she burst into tears. She had been intently watching the death-struggles of a favorite bird. Though the brain was thus absorbed, the spinal cord had not been diverted from the office of carrying on the muscular and automatic actions required by her musical performance.

In somnambulism the brain is asleep, and this quiescent state of the organ is often accompanied, in nervous and excitable persons, by an exalted condition of the spinal cord, and then we have the highest order of somnambulic manifestations, such as walking and the performance of complex and apparently systematic movements. If the sleep of the brain be somewhat less profound, and the spinal cord less excitable, the somnambulic manifestations do not extend beyond sleep-talking; a still less degree of cerebral inaction and of spinal irritability produces simply a restless sleep and a little muttering; and when the sleep is perfectly natural, and the nervous system of the individual well balanced, the movements do not extend beyond changing the position of the head and limbs and turning over in bed.

The phenomena of catalepsy, trance, and ecstasy are also indicative of an independent action of the spinal cord, inasmuch as the power of the brain is not exercised over the body, but is either quiescent or engrossed with subjects which have made a strong impression upon it. Some of the manifestations of mind shown under such conditions are exceedingly interesting, and are altogether outside of the domain of cerebral consciousness.

But notwithstanding the fact that the sympathetic system and the spinal cord share with the brain the office of producing mind, there is no question that this last-named organ, immeasurably in man at least, transcends them in power.

The brain is by far the largest mass of nerve-substance contained in the body of any animal possessing a brain; indeed, it far exceeds in bulk and weight all the rest of the nervous system together. The researches of European observers give 49½ ounces as the weight of the average brain of the white inhabitants of Europe—the maximum, that of Cuvier, being 64⅓ ounces, and the minimum, consistent with a fair degree of intelligence, 34 ounces. Webster's brain (allowance being made for disease which existed) weighed 63¾ ounces, Dr. Abercrombie's 63 ounces, and Spurzheim's $55\frac{1}{16}$ ounces. The average of twenty-four American brains, accurately weighed by Dr. Ira Russell, was 52·06 ounces—the maximum 64 and the minimum 44·25 ounces. The same observer found the average full negro brain, as determined from 147 specimens, to be but 46·96 ounces.

The capacity of Daniel Webster's cranium was the largest on record, being 122 cubic inches. That of the Teutonic family, including English, Germans, and Americans, is 92 cubic inches. In the native African negro it is 83 cubic inches, and in the Australian and Hottentot but 75. The brain of the idiot seldom weighs over 23 ounces, and it is often much less than this. In one instance coming under my own observation, the weight of the entire brain was but 14½ ounces. Mr. Gore has related in the "Anthropological Review" the particulars of a case of microcephaly in which the brain weighed but 10 ounces and 5 grains. The subject, a female, though forty-two years of age, had

an intellect which is described as infantine. She could say a few words, such as "good," "child," "morning," with tolerable distinctness, but without connection or clear meaning, and was quite incapable of anything like conversation. Her habits were decent and cleanly, but she could not feed herself—at least with any degree of method or precision. She was fond of carrying and nursing a doll. In a case described in a subsequent number of the same journal, by Professor Marshall, the weight of the entire brain was but 8½ ounces. The subject was a boy twelve years of age. Nothing is said relative to the intelligence manifested.

Absolutely, the normal human brain is larger than that of any other animal, except that of the elephant and the whale. *Relatively to the weight of the body*, it very greatly exceeds the proportion existing in either. Leuret found the mean proportional weight of the brain to the rest of the body to be in fishes as 1 to 5,668. The range in these animals is, however, very great. In the bass, I found it, as the result of eleven observations, to be as 1 to 523; in the eel, twenty-two observations, as 1 to 1,429; and in the gar-fish, nine observations, as 1 to 8,915.

In reptiles of different orders Leuret determined the average to be as 1 to 1,321. I found the proportion in frogs to be as 1 to 520; in lizards, as 1 to 180; and, in the rattlesnake, as 1 to 1,825. The brain of an alligator, over six feet in length, which I examined, weighed but a little over half an ounce.

Next in order come the birds, and here we find a very decided increase in the proportion. From many determinations made by Haller, Cuvier, Carus, and himself, Leuret gives the average as 1 to 212. In the tomtit he found it as 1 to 12; in the canary-bird, as 1 to 14; in the pigeon, as 1 to 91; in the duck, as 1 to 241; in the chicken, as 1 to 377; and, in the goose, as 1 to 3,600. These are very great differences, and, as Leuret remarks, have no constant relation to the intelligence. It is worthy of notice that the brain is proportionally smaller in those birds which are domesticated, and which, consequently, do not have to make so severe a struggle for existence, than in the wild birds; and their brains, therefore, are more encumbered by fat. From determinations that I made, it was ascertained that the brain of the canary-bird reared in the United States was in weight compared to that of the body as 1 to 10·5, and in the Arctic sparrow as 1 to 11. No observations on record show proportionally larger brains than these.

Among mammals we find a still greater increase in the weight of the brain as compared with that of the body. Leuret found it to range in the monkeys from as 1 to 22, 24, and 25; in the dolphin it was as 1 to 36; in the cat, as 1 to 94; in the rat, as 1 to 130; in the fox, as 1 to 205; in the dog, as 1 to 305; in the sheep, as 1 to 351; in the horse, as 1 to 700; and, in the ox, as 1 to 750. The mean for

the class of mammals, exclusive of man, was as 1 to 186. My own observations accord very closely with those of Leuret. I found that in the prairie-wolf the proportion between the brain and the body was as 1 to 220 ; in the wild cat, as 1 to 158 ; and in the rat, as 1 to 132.

If these figures teach anything at all, it is that there is no definite relation existing between the intelligence of animals and the absolute or relative size of the brain. It is true that, taking the data collected by Leuret as the basis, there is a well-defined relation between the mental development and the brain, as regards the several classes of vertebrate animals ; for in fishes, the lowest, the brain is but one 5,668th part of the body ; in reptiles, the next highest, it is one 1,321st part ; in birds, next in the ascending scale, it is one 212th part ; and in mammals, the highest of all, one 186th part. There is, therefore, beginning with the lowest class, a regular ascent in the volume of the brain till it reaches the maximum in mammals.

But, when we look at the relation as it exists between the different orders and genera of any one class, we can not say that there is any such variation in the degree of mental development as we should expect to find if the brain were the only source of the intelligence, and some members of the very lowest class have relatively larger brains than certain animals of the very highest. Thus, the brain of the bass is to the body as 1 to 523, while in the horse it is but as 1 to 700, and in the ox as 1 to 750. If the relative size of the brain is to be taken as an indication of the degree of intelligence, we must regard the bass as a more intellectual animal than either the horse or the ox. The lizard has a brain which bears the high proportion to the body of 1 to 180. This is greater than that existing in the fox, the dog, the sheep, and several other mammals. The canary-bird and the Arctic sparrow have brains proportionately larger than those of any other known animals, including man, and yet no one will contend that these animals stand at the top of the scale of mental development. Man, who certainly stands at the head of the class of mammals, and of all other animals, so far as mind is concerned, rarely has a brain more than one fiftieth the weight of the body, a proportion which is much greater in several other mammals, and is, as we have seen, exceeded by many of the smaller birds.

Even in absolute weight, independent of any relation to the rest of the body, the brain of man is not the largest, being exceeded by that of the elephant and the whale. But, when we inquire into the matter of the absolute and relative quantity of gray nerve-tissue, we find that in this respect man stands pre-eminent ; and it is to this fact that he owes the great mental development which places him so far above all other living beings, for it is the gray tissue which originates mind—the white, as is well known, serving only for the transmission of impressions and impulses. Unless regard is paid to this point, we should certainly fall into serious error in determining the relation

existing between the mind and the nervous system; but, having it in view, the connection is at once clear and well defined, there being no exception to the law that the mental development is in direct proportion to the amount of gray matter entering into the composition of the nervous system of any animal of any kind whatever.

A point which attracts a good deal of attention at the present day is that which relates to the differences in the brain and mind as exhibited in the sexes of the human species. A few words on this division of the subject may not, therefore, be out of place.

The skull of the male is of greater capacity than that of the female, and it is a singular fact that the difference in favor of the male increases with civilization. Thus, in savage nations, as the Australians and the negroes of Africa, the skulls of men and women are much more alike in size than they are in Europeans. It would appear from this fact either that women, from some cause or other, have not availed themselves of the advantages of civilization, as factors in brain development, to the same extent that man has; or that, among savages, there is not that dissimilarity in mental work that is found in civilized nations; and that, hence, there is not the same necessity for a difference in brain-development.

For it naturally follows that, in the normal skull, there is a correspondence between its size and that of the organ contained within it. Many observations have shown that the average male brain weighs a little over forty-nine ounces, while the average female brain is a little over forty-four ounces, or about five ounces less. The proportion existing between the two is, therefore, as 100 to 90.

This apparently makes a good showing for man, but, when we look at the matter in another and possibly a more correct light, the advantage is rather the other way, for, relatively to the weight of the body in the two sexes, the difference, what there is, is in favor of woman. The body of the female is shorter, and weighs less, than that of the male. Thus, in man the weight of the brain to that of the body has been found to be an average of 1 to 36·50, while in woman it was as 1 to 36·46. I have said that *possibly* this may be a more correct way of determining the size of the brain than by absolute measurements, without regard to the size of the body. The doubt arises from the fact that we do not know that very thin persons, in whom, of course, other things being equal, the brain would be relatively larger, are more remarkable for mental vigor than very stout ones, in whom the relative size of the brain would be less. Such being the case, it is difficult to believe that the proportionate size of the brain to that of the body has any important influence as a factor in the production of mind. It is the *absolute*, rather than the relative, amount of gray matter that is to be considered in determining the brain-power.

It must, however, be borne in mind that the quantity of gray matter can not be positively affirmed from a determination of the size

of the brain, though in general it can. A person, for instance, may have a large head and a large brain, and the layer of cortical substance be very thin; and another person, with a smaller brain, may have the cortex so thick as to more than compensate for its small superficies. Still, these are exceptional cases. As a rule, the larger the brain, the greater the mental power of the individual.

Another difference between the brain of man and that of woman is found in the conformation of the organ. In man the frontal region is more developed than it is in woman. There is a certain fissure, called the fissure of Rolando, which I point out here on this model. Now, if we take the entire length of the brain as = 100, there will be found in woman 31·3 in front of the upper end of this fissure, while in man there will be 43·9.

Again, the specific gravity of the male brain, both of the white and the gray substance, is greater in man than it is in woman.

It is difficult from these facts to avoid the conclusion that the mind must also be different in the two sexes—not necessarily that one is superior to the other, but that they are different. In some respects that of man excels, in other respects that of woman predominates. It would be a bad state of affairs for mankind if the mind in the two primary divisions of the human race were the same. In barbarous nations, as we have seen, the difference in size is less than it is with civilized peoples, and as one consequence of this fact we find that there is not so great a difference in the mental development. The work of a woman with these is almost the same as that of a man. Her mode of life, her dress, are not essentially different, except in so far as they *must* be different on account of her sex. But with civilized nations there is variety in modes of thought and in other mental characteristics, in occupation, in manner, in dress, so that the differentiation between the sexes is far more distinctly marked than it is in the nations low in the scale of progress. Who can doubt that this is the direct result of difference, not only in the brain but in other parts of the nervous system? It appears to me, therefore, that while the education of a woman should be just as thorough as that of a man, it ought not to be the same. The two sexes move along paths that approach parallelism at some points of their course, but they can never travel exactly the same road till they have nervous systems presenting exactly the same anatomical configuration and structure.

Another point—and it is one of such practical importance that it would scarcely do for me to pass it over—and that is the influence of age in affecting the relations existing between the mind and the nervous system.

Most civilized communities have enacted laws against the employment of children in severe physical labor. This is well enough, for the muscles of young persons are tender and weak, and not therefore adapted to the work to which cupidity or ignorance would otherwise

subject them. But no such fostering care does the State take of the brains of the young. There are no laws to prevent the undeveloped nervous system being overtasked and brought to disease or even absolute destruction. Every physician sees cases of the kind, and wonders how parents of intelligence can be so blind to the welfare of their offspring as to force or even to allow their brains to be worked to a degree that in many cases results in idiocy or death. Only a few months ago I saw for the first time a boy of five years of age, with a large head, a prominent forehead, and all the other signs of mental precocity. He had read the first volume of Bryant's "History of the United States," and was preparing to tackle the other volumes! He read the magazines of the day with as much interest as did his father, and conversed with equal facility on the politics of the period. But a few weeks before I saw him he had begun to walk in his sleep, then chorea had made its appearance, and on the day before he was brought to me he had had a well-marked epileptic paroxysm. Already his mind is weakened—perhaps permanently so. Such cases are not isolated ones. They are continually occurring.

The period of early childhood—say up to seven or eight years of age—is that during which the brain and other parts of the nervous system are most actively developing, in order to fit them for the great work before them. It is safe to say that the only instruction given during this time should be that which consists in teaching children how to observe. The perceptive faculties alone should be made the subjects of systematic attempts at development. The child should be taught how to use its senses, and especially how to see, hear, and touch. In this manner knowledge would be acquired in the way that is pre-eminently the natural way, and ample food would be furnished for the child's reflective powers.

And now I must bring these remarks to a close, although there is a great deal yet that, were there time, and I were not afraid of wearying you, I should be glad to say. One point, however, must not be overlooked, and that is, the occasion that enables me to come before you at all. It is not likely that the world, and especially Pennsylvania, will ever forget the wise man who laid the foundations of this institution of learning. It is not yet venerable by age, but, when it counts as many centuries of existence as it now counts years, the name of Asa Packer will stand first among those that it will delight to honor. More than forty years ago, when I was a boy in Harrisburg, and he was a State Senator from Northampton County, I knew him well, and his personal appearance and manner are firmly fixed in my mind as he was then, a man of perhaps thirty-five to forty years of age. I recollect that upon one occasion I met him at the corner of Market and Third Streets, as he was on his way to the Capitol, and that he invited me to walk with him to the building. I was then a school-boy, and he questioned me very closely in regard to the profession I proposed

to adopt. I had then no very positive ideas on the subject. I had thought of the church, of law, and of medicine, and so I told him. We were then about half-way up the board-walk that extended from the corner of Third and Walnut Streets to the Capitol-grounds. He stopped, and, turning to me, said: "Ah, my young friend, the most difficult task you have before you is to make the right choice. A bad start at the beginning is almost certain to result in a bad race and a bad finish. Don't leave it to chance. Think it over, and then decide."

I thanked him.

"One thing more," he said. "If, after you have decided, you find that you have acted hastily and without the knowledge of yourself that was necessary, don't be afraid or ashamed to change. Don't stick to a profession for which you are unsuited merely for the sake of sticking. It is better, however, to be sure in the first place."

Perhaps even at that time he had it in his mind to found this university. The world knows that he made no mistake. He had determined what to do, and how to do it; his brain worked easily and it worked well; and what he apparently did in the way of accumulating wealth for his own advantage was in reality done for the advantage of his fellow-creatures, whom he loved as members of the universal brotherhood to which he belonged.

GERMAN TESTIMONY ON THE CLASSICS QUESTION.

By FREDERIK A. FERNALD.

THE German practical-schools (*Realschulen*) are a recent institution as compared with the classical-schools (*Gymnasien*), and have never yet obtained more than a scanty allowance from the public treasury, from which their ancient rivals have long received an abundant support. But, in spite of this and many other disadvantages, the practical-schools have gradually increased in efficiency until they now furnish a training which, in the opinion of a large party in Germany, prepares students to enter upon a university course. In compliance with the demand of this party, the Prussian Minister of Public Instruction, in December, 1870, ordered that graduates of practical-schools of the first class should be admitted to courses in modern languages, mathematics, and natural science, at the universities of Prussia, withholding from them, however, admission to the studies of mental philosophy, philology, history, political economy, law, theology, and medicine, and leaving closed the avenues to the majority of state appointments, which are immensely more important to university men in Germany than in the United States. After an experience of eight years the Philosophical faculty of the Friedrich Wilhelm

University in Berlin reported that the graduates of the practical-schools were poorer material than those sent up from the older schools, and assigned theoretical reasons for the deficiency. This report has been widely quoted in this country as deciding a question on which it had little, if any, bearing—namely, whether Latin and Greek are the best studies for early mental training. Great capital was likewise made of the fact that Professor Hofmann, who is a chemist, on assuming the rectorship of the University of Berlin, reiterated the conclusions of the faculty, and apparently acknowledged the pre-eminence claimed for the classics; but it is quite significant that the classical men failed to get any such public utterance from him during his visit to the United States last fall as they got from Lord Coleridge and Matthew Arnold. The numerous causes and considerations which led to the adverse report of the Berlin faculty have been ably set forth by Professor E. J. James, in an article on "The Classical Question in Germany," published in "The Popular Science Monthly" for January, 1884.

But the impression still persists that this decision of the principal state university in favor of the classical-schools and against the practical-schools, has something of the import of a German Government manifesto, and of a final answer to the question, upon which the culture and scholarship of that country are agreed. This, however, is a very great mistake. So far from quieting it, the celebrated Berlin report did not have sufficient influence in its own country to materially check the agitation of the classics question. The controversy over the traditional classical study, of which the practical-schools are a product, had raged long and hotly, taking a profound hold of the public mind, and the discussion goes on without abatement of interest or vigor, as may be inferred from the following introduction to a pamphlet * written nine months after the presentation of the report:

"The present condition of our secondary-school system must incite every thinking person to serious reflection. We see a school for the cultivated, aiming almost exclusively at acquaintance with classical antiquity, while an indescribable ignorance of the ancient civilization prevails among almost all classes; an eternal dispute in the daily press, and in most circles, as to whether Latin or Greek or both are indispensable in education; and a vast gulf between the two prevailing cultures, due to the difference between the ideals of the classical-school and of the practical-school. There is also a restless fluctuation in the prescriptions for the examination of one-year volunteers; a violent contest in regard to whether admission to the study of medicine shall be confined to classical-school graduates; and, finally, a decrease, perceptible to the superficial observer even, of intellectual workers, which means a general abatement of intellectual life so far

* "Betrachtungen über unser classisches Schulwesen," Leipsic, Verlag von Ambr. Abel, 1881.

as it is not comprised in the profession of the individual, and which is visible not only when men are observed as they come together in society, but also in their domestic lives. These things present an unpleasing aspect, and incite us to search for their cause and to devise means of correcting them. How much the school question is already occupying the attention of thinking men is shown by the multitude of pamphlets which yearly flood the book-market."

After a hasty glance at the history of the German classical-school, this writer presents his indictment of the study of Latin and Greek, and supports his view by a host of citations from German authorities, some of which we give in the present article. He says:

"The learning of Latin has no more cultivating influence than the learning of any modern cultivated language, while other considerations strongly urge the introduction of French and English into the course of study of the secondary schools in place of Latin. The acquaintance with Latin which the learned require could be obtained during the last three years, in voluntary classes, and in a different way from the one in vogue.

"It is, indeed, undeniable that acquaintance with the ancient civilization is an important force in modern civilization, but a view of the classic world of the Greeks and Romans may be had without acquiring the ancient languages.

"When the number of hours devoted to the ancient languages in nine school-years is impartially set beside the results which are obtained, this expenditure of time must be accounted unjustifiable.

"Knowledge of classical antiquity and its authors is in a steady decline among the learned, and for this sad state of affairs modern classical philology is to be held accountable."

The claim that the reading of ancient authors is the only adequate means of becoming acquainted with the ancient civilization is not supported by the results. As President Eliot says, "It is a very rare scholar who has not learned much more about the Jews, the Greeks, or the Romans, through English than through Hebrew, Greek, or Latin." The obviously proper procedure is for the student to learn the broad traits of a people and their civilization through his own language, and then to glean by means of the ancient language whatever has so far escaped him. The experience of our pamphleteer in respect to this is very instructive:

"It was a source of continual wonder to me in my school-days, that some of my fellows, who attended the common school (*Bürgerschule*), actually knew more about the times of Pericles and Augustus than we, the learned Latinists and Greekists. The reason was, that in the common school there taught the author of a well-known history, who knew how to combine intimately the study of history, of literature, and of manners and customs, so that the boys obtained a lively introduction to ancient times, while we had to give our attention to

the language of the classic writers in the Latin and Greek classes, and the history class, for which we had to learn by heart the dry paragraphs of an outline, was entirely disconnected from them."

On this point Paul Pfizer wrote in his "Correspondence of Two Germans" (1831): "In the construing of ancient writers, as it is carried on in the schools, the spirit of modern life is simply lost, without that of the past being gained. . . . Among us twelve years of youthful life is sacrificed to the study of a dead language which the student learns neither to speak nor to write, and very promptly forgets, while the opportunities of parading this unfruitful possession are becoming scarcer and scarcer."

The slight acquaintance with antiquity and the imperfect command of the classical languages gained by school-boys having been often pointed out, the study is now defended mainly on the ground that the most valuable mental exercise is obtained from wrestling with the grammars. It is interesting to note what value this use of the dead languages had in the estimation of Herder:

"As soon as learning Latin is made an end, and this in itself so pleasing and useful language is no longer employed as a means of learning history, of looking into the minds of great men, and of making one's own the whole field of an excellently developed language, then the Muses of Latium are allowed too much space in the schools. To be more particular, if the interpretation of an author affords nothing but words and mechanical style for the pupils to learn, if the method of the teacher has for its chief aim only the grammatical choice and arrangement of words, and if the whole school or educational system is controlled by a certain *Latin spirit*, which must produce a sad deficiency in other branches, then, however admirable and useful the Latin language may be, too much is sacrificed to it."

Again, Paul Pfizer: "The fact that from the 'school of the ancients' excellent men have come forth proves nothing as to the exclusive pre-eminence of Latin-learning, with its eternal translating, its verse-making, and its phrase-twisting. Not from the school of the ancients, but from the hand of Nature, have these men come forth, and the acquiring of Arabic or Persian would have done them about the same service."

It may be objected that most teachers of the classics do not report any such discouraging failures. Are they not likely to know best the condition of their own business? The pamphlet before me contains a passage which shows that declarations of teachers, among which the famous "Berlin report" should be counted, must be taken with several grains of salt, thus aptly re-enforcing the article by Professor James already referred to:

"The resolutions which are passed by bodies of teachers can not be regarded as representing the actual state of affairs. Against the complaints or remonstrances of the laity the teachers stand as one

man, and decide that there is nothing at all to complain of. That is the way they always do when fault is found with their neglect of health and bodily culture, and when, every couple of years, complaints are made of the overloading the pupils with work. Moreover, if they withhold and deny their opinions in deference to Government, how can any dependence be placed on their conclusions? At a recent meeting of practical-school teachers, one of them spoke against the extension of the study of Latin in the practical-school, and moved a resolution in reference to it. One of the wiseacres present promptly objected that this ought not to pass, for *he knew that the authorities laid great stress on Latin!* . . . Conventions of physicians have advanced as a chief reason why admission to the study of medicine should be refused to practical-school graduates, that by this means the social position of physicians would be injured."

To this may be added a few sentences from Herder:

"And then can a view, although it should be recognized as the true one, destroy prejudices deeply rooted since youth, which have become a second nature to the instructors? . . . Can it so seize upon pedantic souls that when it shows itself in full light it shall cause them to act in accordance with it? . . . Oppressed spirits! martyrs of a Latin education! O that you could all cry aloud!"

The reason why the two most widely known German writers can not be quoted with Herder, Pfizer, Richter, and the others, on this side of the question, is thus stated in the pamphlet before me:

"If it occurs to any one that testimony from Goethe and Schiller is almost entirely lacking, let him remember that neither of the poets had attended the higher *Normalschule* of his time. Schiller was a pupil of the *Karlsschule*, which had long ceased to occupy the narrow ground of the classical-schools of the time, and Goethe received a careful and varied private instruction, and hence did not suffer from the contemporary school education."

Leaving now the course of study of the classical-schools, the author proceeds to dispel a delusion which the utterances of numerous speakers and writers during the past year has shown to prevail even more in the United States than in Germany.

"Since we have made so many and, in the eyes of many persons, so spiteful attacks on the classical-school, it might be supposed that the modern practical-school is the El Dorado in which we see our pedagogic desires realized. It is, indeed, astonishing, we declare it thankfully, what a fresh and active life the practical-school, formerly treated in such a step-motherly way by the state, has developed in often victorious competition with the sluggish, though officially fondled and fostered, classical-school; how brightly and sturdily there have come up in it not only the natural sciences, but also, to the shame of the classical-schools it must be said, the study of the German language and literature, but we must remain true to our ideal of education and

not allow the heritage of the ancient humanistic culture to this inconsistent system. . . . Through many practical-schools—and this often less on account of the studies taught than of the superficially practical training of the teachers—there runs a certain strain of philosophical and ethical crudity. That many teachers possess only a scientific and partial culture is generally less their own fault than that of the irregularity which characterizes the examinations of these teachers by the authorities.

"It is a most ridiculous position which Latin occupies in the practical-school. It bears no relation to any of the other branches, and, since the pupils learn French quicker than Latin, it is senseless to say that they learn Latin in order to be able to learn the modern languages."

The author then sketches the course of study of the ideal secondary school, but fails to preserve the proper balance between the several studies, from having no adequate conception of an important one of them. He has something to say about natural science, but does not know why, how, or when it should be studied. Apparently no glimmer of psychology has ever entered his mind; at least, not a ray is reflected. Not sufficiently conscious of his defect to refrain from what he is incompetent to perform, he is yet so far aware of it as to make a confession in these words:

"Unfortunately we ourselves, thanks to our classical training, are too strange in this realm to be able to determine how far and in what way the sciences referred to are to be taught in school without either those parts of the natural sciences which constitute an element of general modern culture being omitted, or things being dragged in which would be better left for presentation by the university instructor. The answers to these questions must come from men who are familiar with the natural sciences without being prepossessed by them."

The advocates of a wider choice of studies in American education are of two classes: One class, admitting the claims of linguistic training to superiority, asks only the option of employing either ancient or modern languages, saving a little space, perhaps, for natural science. The other class holds, first of all, that the art of education must be based upon the science of psychology, and that the symmetrical development and highest efficiency of the mind can be secured only through a training which gives the due amount of exercise to each faculty. It has long been recognized as an absurdity to suppose that the muscular part of the human organism gets its best development from any one kind of hard work. The stone-cutter or machinist may have strong arms, with very defective legs. The coal-heaver will be strong in the back, but will have a stooping posture and a cramped chest; much rowing produces about the same development. Similarly with the brain. The most prolonged and severe exercise of the memory will not perceptibly improve the observing powers, and no amount of drill

in observation will secure a full development of the powers of abstract thought. This matter is very fully and clearly set forth in Mr. James Sully's new work, "Outlines of Psychology." "In the second place," continues Mr. Sully, "the whole scheme of training should conform to the natural order of development of the faculties. Those faculties which develop first must be exercised first. It is vain, for example, to try to cultivate the power of abstraction before the powers of observation (perception) and imagination have reached a certain degree of strength. This self-evident proposition is one of the best accepted principles in the modern theory of education, though there is reason to apprehend that it is still frequently violated in practice."

The course of study for boys until they are eighteen years old which conforms to these principles would be as follows: Since sensation is the first faculty to be born, the first lessons should consist in presenting to the child objects on which he can exercise this faculty. This is the method of the Kindergarten, and has sufficiently demonstrated its wisdom. Gradually the child should be led to make more and more minute and complete observations, and plants, animals, and minerals should be put within his reach for comparison and classification. Next he should be set to discovering the physical properties of matter and the laws of force, and after this the chemical properties of matter should be investigated to some extent. Human physiology and hygiene should also form a part of the course. These subjects should be so arranged that a part of the pupil's time throughout his school course would be devoted to the scientific method of studying things, which is a far different matter from committing to memory the pages of the ordinary text-book on science, or sitting passively like a pitcher under a spout while the teacher pours information into listless ears, perhaps showing experiments and specimens, and telling the pupils what to see. The benefits of scientific culture have been often and ably stated. One of the most important is that it prevents the disastrous credulity which prevails even among those accounted well educated according to the ancient standard. If the opponents of science had been familiar with the scientific method of getting at truth, as exemplified, for instance, by the classical experiments, of Sir Humphry Davy on the electrolysis of water, they would not have so eagerly published their understanding of the "Berlin report" without a single attempt to eliminate sources of error.

The study of language also should run through the whole school course. The process of learning to talk should be continued in the school, the pupil's discoveries about things furnishing the subject-matter on which to exercise his powers of expression. He should begin early to write a part of what he has to say, and may thus be introduced to Composition without knowing the dread which that big name commonly inspires in the minds of school-children. Elocution should receive some attention, and the derivation and composition of

English words should be studied to the extent that they aid in remembering distinctions in meanings. The pupil should obtain also some adequate knowledge of the history of English literature, and of its extent, its beauties, grandeur, and wisdom. At present students are admitted to the best American colleges, whose ignorance of their native language and its literature is positively shameful. The study of grammar should not begin until the boy is sixteen years old. At twelve or fourteen years old he may begin to learn to talk in another modern language, and may continue the study of this language to the end of his school course. These are enough subjects in language; the other modern languages and Latin and Greek should be left to the college course, as German, Spanish, Italian, and Hebrew commonly are. In direct opposition to this method of procedure is the practice of putting boys into the grammatical study of languages at ten or eleven years of age, and its pernicious effect is well stated by Herder:

"The first color which our mode of thinking takes on never fades; alas for us if it is a disagreeable or an actually disfiguring one! The friend of humanity must sigh when he sees how, in the schools which parade the name 'Latin school,' the first young desire is wearied, the first fresh strength is restrained, talent is buried in the dust, and genius is held back until, like a spring too long bent, it loses its power. Who would ever get into the notion that the system of *linguistic education* is suitable for youth, if he only set himself outside of our habit of thought?—but how difficult it is to set one's self outside of it!"

The opinions of our pamphleteer on the study of languages are well worth quoting:

"The chief place in the German school of the future should be held by a course of instruction in the German language and literature which aims at so training youth that at the end of their school-years they shall be adepts in speaking, reading, and writing their mother-tongue, and shall, besides being familiar with the copious vocabulary of the language, have become acquainted also with its literary monuments and imbued with the intellectual spirit of their nation. It is obvious that, in order to turn out such pupils, teachers are needed who know more than some Gothic and Middle High German, and it is also obvious that in order to obtain such teachers, those learned men should not act at the university who have lost the spirit in turning over the words, and who, moreover, pass off this spiritlessness for scholarliness.

"French and English also have large claims: first, because an acquaintance with these languages is absolutely necessary in many callings, and is always very useful to the educated; second, because the civilizations of the French and English peoples stand in the most intimate relations with ours; and, third, because he who has mastered these two languages no longer has the trammeled feeling that his path of life is confined to his native sod, but he can turn his steps to any part of

the civilized world to seek his fortune, if he does not find it at home. The instruction in these languages, which, being living languages, must be treated accordingly, can properly aim only to teach the pupils to speak, read, and write them. Without neglecting the practical considerations, the pupils may be exercised in logical thinking by means of the grammars of these languages, and in the upper classes their lingual facility may be increased by free translation into German. Surveys of the literatures of the two peoples, with specimens, will incite talented pupils to devote themselves to the thorough study of these literatures at the university."

Americans who had given adequate attention to modern languages would be able to read such valuable documents as the "Berlin report" and Dr. Hofmann's address, without understanding the word "*wissenschaftlich*" in a much-quoted passage to mean "scientific," relating to natural science, when it really means relating to knowledge, scholarly. *Die schoenen Wissenschaften* are not a class of natural sciences, but polite literature. The complaint that modern languages are too easy to afford valuable mental discipline should not be urged by writers who make such slips in German.

The postponing of Latin grammar until the pupil's mind approaches maturity is thus emphatically indorsed by Jean Paul Richter: "It pleased me to hear you state that you would have French come before Latin, speaking before grammatical rules (i. e., the go-cart before the theories of muscular action), and have the ancient languages taken up later, because they are taken in more by the reason than by the memory. Latin is so hard partly because it is brought on so early; in his fifteenth year, a boy accomplishes in it with one finger what he would take the whole hand for earlier." In full agreement with Richter's view is the following passage from Paul Pfizer: "Or is it maintained by the majority of our philological and humanistic instructors that in them antiquity is alive? And what is not the case among the teachers, will that be among the pupils? It is maintained that there is nothing more alive than the writings of the ancients. But in order to enter into this life, to become at home in a strange world, and to awaken the past again in one's self, a fullness of creative power is required, and a maturity of spirit and insight, such as are never to be found in youth."

I have known young men who did not decide to go to college until they were eighteen or twenty years old, and then accomplished in two years or less the preparation in Greek and Latin which drags over four to six years in the ordinary preparatory school. Students at Harvard learn enough German during the freshman year to be able to translate three pages at a lesson from such a book as Schiller's "Thirty Years' War." When students elect Hebrew or Sanskrit they make proportionate progress, hence it must be admitted that the knowledge of Greek and Latin required by the man of general culture, not the spe-

cialist who expects to earn his bread and butter by teaching the classics, may be gained after the student has entered college in half the time commonly devoted to its acquisition in the schools.

The ideal school course would allow a share of time to mathematics continuously, and this subject may be passed over with a few words, not because it is unimportant, but because, unlike Greek and Latin, it "needs no bush." It may be mentioned that practice in deductive reasoning, for which mathematics is chiefly recommended, is obtained especially from "mental" arithmetic and geometry, while "written" arithmetic and algebra are less important for this purpose. Some time must be devoted to learning those facts of physical and political geography which the educated man is expected to know. Every English-speaking boy should become familiar with the history of the English race, and, if there is time for anything more, this suggestion in the pamphlet from which I have been quoting deserves attention: "To make amends for abandoning the study of Latin and Greek authors, an affectionate look into the life of antiquity should be taken. Besides reviewing historically the literature and civilization of the ancients, good translations of the classics should be diligently and spiritedly read and explained, in order that the vanished interest may be recalled, and that the now qualified pupil may be spurred on to take the optional instruction in the Latin and Greek languages in the upper classes, and tread the path to the original sources."

Those who can spare time for these studies are to be congratulated, as are those who have the opportunity to study the history of the fine arts, or Egyptology. But as "flowers out of place" are called weeds, so the study of antiquity becomes noxious when it crowds more beneficial studies. An additional instance of such crowding is contained in the following:

"It is passing strange that, during the long period of their education, the rising generation should never hear an earthly syllable about the constitution and administration of their nation, about their own civil rights and duties, about matters of finance, etc. Of course, there is no time for this in a school in which the pupils learn exactly how the 'revenue-administration of the Athenians' was constituted, what salary a Roman judge received, and what share of his father's property the noble-born Attic youth was entitled to."

Much the same view was taken by Paul Pfizer: "The wisest peoples held the subject of education to be worthy of the most careful attention and the deepest reflection; but, since education has no longer any reference to the state and to public life, since the duty of the educator has been made merely to be at home in a world which perished long ago, and to take no cognizance of his native land, it has covered itself with the dust of the school, and assumed the color of the ridiculous and the pedantic."

Would not a boy who had completed the course just outlined be

prepared to enter upon the studies of a university? The number of those who firmly believe that substantially this course is the best for all boys up to the usual college age is rapidly increasing. They are active and in earnest, and are making their influence felt; but mark what they ask—not that all boys shall be required to take this training, but that boys so trained shall be admitted to equal privileges with those trained in the old way. They would put the two methods squarely side by side, confident of the survival of the fittest. Those defenders of the classics who would anticipate a decline in the study of Greek and Latin under these conditions, have little faith in the justness of their own claims.

ORIGIN OF THE SYNTHETIC PHILOSOPHY.*

By HERBERT SPENCER.

To the Editor of the Times.

SIR: As you have placed before a multitude of readers Mr. Frederic Harrison's anniversary address on "The Memory of Auguste Comte and his True Works," I may, I think, properly ask you to place before the same readers the disproof of a statement made by Mr. Harrison which gravely compromises me. He said that "Mr. Herbert Spencer, who had written a book to explain his divergences from Comte, was himself in all essentials his unconscious imitator, 'Synthetic Philosophy' being nothing but an attempt to play a new tune upon Comte's instrument. All the *idées-mères*, as the French said, of the Synthetic Philosophy, were those of the Positive Philosophy. Had there been no Comte, assuredly there would have been no Spencer." Even had I no other motive than that of showing my independence of Comte, I should, I think, be justified in not allowing this statement to pass unchallenged. But I have a further motive. As I have recently been passing a very outspoken judgment on the absurdities of the Comtean religion, the above passage implies that I have been ridiculing a man to whom I am deeply indebted, and the desire to clear myself from this aspersion compels me to speak.

A reader of literary history, struck as he must be with the numerous disputes about originality and priority, might sum up the result in somewhat Irish fashion by saying—No man's ideas are his own; they always belong to somebody else. My experiences might serve to support his paradox. Three distinct origins have been assigned for the Synthetic Philosophy. The current belief is that I have simply accepted Mr. Darwin's doctrine, and occupied myself in giving to it a wider extension; the truth being that the essential principles of the Synthetic Philosophy were set forth by me in two essays on "Progress:

* From the "Times" of September 9, 1884.

its Law and Cause," and on "The Ultimate Laws of Physiology," published respectively in the "Westminster Review" and the "National Review" (not the periodical now bearing that title) in April and October, 1857, more than two years before the publication of "The Origin of Species." Another source was not very long since alleged by the Rev. Thomas Mozley. In his "Reminiscences," etc., when giving an account of the influence exercised over him by my father, of whom he was a pupil, he describes himself as deriving from my father certain ideas which led him to think out a philosophy of like general nature with that set forth by me; but when, after enumerating the cardinal ideas of the Synthetic Philosophy, I requested him to point out any one of them which was contained in his own "elder philosophy," as he called it, he did not do so, and said all he meant by "family likeness" was such family likeness as might be alleged between "Cardinal Newman's view and his brother Frank's." * And now comes Mr. Harrison, repeating the assertion made twenty years ago, and then refuted by me, that I am indebted to Comte—nay, that I owe to him "all the *idées-mères*" of the Synthetic Philosophy. These three different beliefs concerning its origin go a long way toward destroying one another. Each by implication contradicting the other two is itself contradicted by them; and being thus severally discredited, they might, perhaps, safely be left as they stand. But readers of Mr. Harrison's address might not consider this sufficient, and I must therefore deal with his statement directly.

In the first sentence of that statement he refers to a *brochure* entitled "The Classification of the Sciences; to which are added Reasons for Dissenting from the Philosophy of M. Comte," originally published in March, 1864. In this I have set down not such "divergences" as might consist with partial acceptance, which Mr. Harrison's statement may lead readers to suppose, but I have given "reasons for dissenting from," and rejecting, Comte's philosophy altogether. I have enumerated six cardinal propositions essentially characterizing the Positive Philosophy, and have set against them six counter-propositions which I hold. I have then gone on to say:

> "Leaving out of his 'Exposition' those pre-established general doctrines which are the common property of modern thinkers, these are the general doctrines which remain—these are the doctrines which fundamentally distinguish his system. From every one of them I dissent. To each proposition I oppose either a widely different proposition or a direct negation; and I not only do it now, but have done it from the time when I became acquainted with his writings. This rejection of his cardinal principles should, I think, alone suffice; but there are sundry other views of his, some of them largely characterizing his system, which I equally reject."

And I have thereupon contrasted four other general views of Comte with the opposite views held by me.

* See "Athenæum," July 22, 1882.

But I do not write this letter merely for the purpose of pointing out these facts. I write it mainly for the purpose of making public the judgment given on the question at issue by the earliest and most distinguished of M. Comte's English adherents, Mr. John Stuart Mill. Before quoting his judgment I must explain how it came to be given, and in doing this must reproduce a letter written by me to him many years ago, which itself contains evidence clearly disproving Mr. Harrison's assertion. Here it is, or rather the first part of it:

"17 Wilmot Street, Derby, *July 29, 1858.*

"My dear Sir: May I ask your opinion on a point partly of personal interest, partly of more general interest?

"In the essays on 'Progress; its Law and Cause,' and on 'Transcendental Physiology,' which I believe you have read, are the rudiments of certain general principles, which, at the time they were first enunciated, I had no intention of developing further. But more recently these general principles, uniting with certain others, whose connection with them I did not before recognize, have evolved into a form far higher than I had ever anticipated; and I now find that the various special ideas which I had designed hereafter to publish on certain divisions of Biology, Psychology, and Sociology, have fallen into their places as parts of the general body of doctrine thus originating. Having intended to continue occupying myself, as hitherto, in writing essays and books embodying these various special ideas, I have become still more anxious to devote my energies to the exposition of these larger views, which include them, and, as I think, reduce all the higher sciences to a rational form."

Has Mr. Harrison any doubt concerning the truth of these statements? If so, he may easily verify them. If he will turn to the second, or constructive, division of "First Principles" (I give the references to the second and subsequent editions, partly because they are most widely distributed), he will find that Chapter XV embodies the argument contained in the first half of the essay on "Progress: its Law and Cause," and incorporates all the illustrative examples along with additional ones; and in Chapter XX he will find the second half of that essay reproduced with all its illustrations, and with further elaborations. Similarly, two fundamental principles set forth in the essay originally published under the title "The Ultimate Laws of Physiology" (but republished in the third volume of my *Essays, etc.*, under the title "Transcendental Physiology"), he will find are severally developed in Chapters XIV and XIX; where, again, the original illustrations will be found joined with numerous others, accompanying a much wider extension of those principles. In these two essays, then, Mr. Harrison will discover the *idées-mères* of the Synthetic Philosophy; and the task before him is to affiliate these ideas, if he can, upon the ideas contained in the Positive Philosophy.

I now come to the opinion expressed by Mr. Mill. When, in 1864, there appeared in the *Revue des Deux Mondes* an article on "First Principles," by M. Auguste Laugel, in which he described me as being

in part a follower of M. Comte, and when I decided to append to "The Classification of the Sciences" the "Reasons for Dissenting from the Philosophy of M. Comte," proving that M. Laugel's belief was erroneous, I bethought me of the above partially-quoted letter. On stating to Mr. Mill why I wanted it, he kindly returned it (not, however, soon enough for use), and with it there came a letter from himself. I give this letter, or rather the first paragraph of it—a paragraph which, under ordinary circumstances, it would be bad taste in me to publish, but which, under the present circumstances, I shall, I think, be held justified in publishing:

"BLACKHEATH, *April 3, 1864.*

"DEAR SIR: I am fortunately able to send you the letter you want. No Englishman who has read both you and Comte can suppose that you have derived much from him. No thinker's conclusions bear more completely the marks of being arrived at by the progressive development of his own original conceptions; while, if there is any previous thinker to whom you owe much, it is evidently (as you yourself say) Sir W. Hamilton. But the opinions in which you agree with Comte, and which, as you truly observe, are in no way peculiar to him, are exactly those which would make French writers class you with him; because to them, Comte and his followers are the only thinkers who represent opposition to their muddy metaphysics."

To this I may fitly add a passage contained in Mr. Mill's work, "Auguste Comte and Positivism," issued a year later, in which, distinguishing between that part of the Positive Philosophy which belongs to Comte and that which "is the common inheritance of thinkers," he says:

"Mr. Spencer rejects nearly all which properly belongs to M. Comte, and in his abridged mode of statement does scanty justice to what he rejects" (p. 5).

Now, considering that Mr. Mill was a profound admirer of M. Comte, kept up a correspondence with him, and raised funds to support him, and considering that when the above letter was written I knew Mr. Mill personally only through two calls at the India House, and was an antagonist of Comtean views which he accepted, and had publicly combated one of his own views, it is manifest that any bias he may be supposed to have had was against me rather than for me. Such being the case, most persons will, I think, regard his voluntarily-given opinion as decisive. HERBERT SPENCER.

ATHENÆUM CLUB, *September 8th.*

Mr. Harrison replied to the foregoing letter, which elicited the following rejoinder from Mr. Spencer:

*To the Editor of the Standard.**

SIR: I regret further to occupy attention with a matter mainly personal, but feel obliged to do so.

* From the London "Standard" of September 15, 1884.

I pointed to the essays in which were contained the *idées-mères* of the Synthetic Philosophy, and gave Mr. Harrison means of finding that they were undeniably such by referring him to parts of "First Principles," in which they were developed; and I then invited him to point out the ideas in the Positive Philosophy from which they were derived. Instead of taking this direct way of establishing filiation, he has sought to establish it in various indirect ways.

He contends that I owe the conception of a "coherent body of doctrine," formed by "the amalgamation of Science, Philosophy, and Religion," to Comte. If he will turn to the Essay on "The Genesis of Science," he will see that my criticism of Comte's Classification of the Sciences is preceded by a criticism of the schemes of Oken and Hegel, both of which profess to be coherent bodies of doctrine formed of Philosophy and the Sciences. Having the three schemes before me, why does Mr. Harrison suppose that Comte, rather than Hegel or Oken, gave me the idea? And why should I not say that Comte was indebted to them, just as others say he was indebted for his *idées-mères* to St. Simon?

He refers to my first work, "Social Statics," as being identical in title with one by Comte. In the pamphlet issued twenty years ago, discussing the question now again raised, I stated that at the close of 1850, when "Social Statics" was published, Comte was to me but a name. It seems that Mr. Harrison did not believe me. There are various proofs, however. Though I have letters showing that "Social Statics" was not the title originally intended, this evidence must be left out, being too long to quote. But there is the sub-title, "The Conditions Essential to Human Happiness Specified, and the First of them Developed." Does this correspond with the substance of Comte's "Social Statics"? Further still, there is the fact, named in the pamphlet above mentioned, that I was blamed by a reviewer of "Social Statics" in the "North British Review" (August, 1851) because I did not "seem to have the slightest notion" of that which Comte understood by Social Statics. And, once more, there is the fact that the ideas and spirit of the book are as utterly alien to those of Comte as can well be. They involve a pronounced individualism, which was one of his aversions.

Because Comte here and there speaks of "synthesis," Mr. Harrison thinks that the title Synthetic Philosophy was derived from him. If he will refer to the programme as originally given, and as continued for ten years or more, he will see that no such title was used. My adoption of it was due simply to the fact that there had been given to the system by my American adherent, Mr. Fiske, the title "Cosmic Philosophy"—a title which I disapproved.

Mr. Harrison says, "Mr. Spencer has written volumes about the 'Social Organism,' 'Social Evolution,' 'Social Environment'; so has Comte." I did not know Comte had used the phrase "Social Organ-

ism"; but if Mr. Harrison will refer to "Social Statics," p. 443 and p. 453, he will find it used at a time when, as I have said, Comte was to me but a name. If Mr. Harrison alleges that anybody who writes about Social Evolution (in past days called Social Progress) must be indebted for the idea to Comte, he is simply illustrating afresh that which all observers are now remarking, that he and his co-disciples find Comte everywhere. As to "Social Environment," I have, I believe, occasionally used the expression; but it makes so little figure that I should be puzzled where to look for it. That the name Sociology was introduced by Comte is doubtless true, and that I have avowedly adopted it is also true: true also that I have been blamed for using this hybrid word. But though the word is his, the idea is not. In its crude form it can be traced as far back as Plato; and long before the time of Comte it assumed a considerable development in the work of Vico—"Scienza Nuova."

"The conception that all things social are amenable to invariable laws and have modes of life analogous to those of physical organisms is one of the most transcendent steps taken in modern thought," says Mr. Harrison. To the first of these statements I have to reply, that if Mr. Harrison will refer to a pamphlet on "The Proper Sphere of Government," written by me when twenty-two, he will find this same conception distinctly expressed and argued from. And to the second I have to reply, 1. That the analogy between the individual organism and the social organism is traceable in Greek thought; and, 2. That it was set forth elaborately, though very erroneously, by Hobbes. To say that "Comte is the unquestioned author of the thought" illustrates afresh the way in which his disciples are possessed by him.

The adoption of the word "Altruism" from Comte is referred to by Mr. Harrison. Here he is perfectly right. I have acknowledged the adoption; and I have also defended it as a very useful word.

Mr. Harrison claims for Comte the distinction between the militant phase of social life and the industrial phase. Is he sure that no one recognized it before? But that I do not owe the conception to him is again sufficiently shown by reference to "Social Statics," pp. 419–434 (original edition), where the essentially different traits of predatory societies and peaceful societies are contrasted, though the words "industrial" and "militant" are not used. Moreover, Comte's conception and mine, respecting the types of social organization proper to the two, are radically opposed.

In the "Principles of Biology," vol. i, p. 74, is a note which, by implication, refutes the statement that I owe the definition of life to Comte. Comte evidently made in the "Positive Philosophy" an approach to the truth, but he strangely missed it. How little he himself regarded what he there said as a definition of life is proved by the fact that he adopted De Blainville's definition. Dr. Bridges says he

reached it in the "Politique Positive." Be it so. That, however, is a work which Mr. Harrison reproaches me with not having read.

But if I go on in this way, meeting one by one Mr. Harrison's allegations, I shall tire your readers before I reach the statement which I think will be held conclusive. My course must be to specify those *idées-mères* which I have indicated to Mr. Harrison, but which he refuses to look for, and then to show how from these the whole doctrine I have set forth gradually grew.

Omitting earlier stages, which I can trace back to 1850, I begin with the essay, "Progress: Its Law and Cause," which was published in 1857. On the second page of that essay I have named the generalization reached by Von Baer, that the changes undergone during the development of every living thing "constitute an advance from homogeneity of structure to heterogeneity of structure." On the next page I have enunciated the thesis of the essay; namely, that "this law of organic progress is the law of all progress"—not progress in a limited sense, but progress inorganic as well as organic, presented throughout the universe, from celestial bodies to such social products as science, art, and literature. How was the evidence supporting this thesis to be presented? By taking the various groups into which all kinds of phenomena are divisible, and showing that the law holds throughout each group, I have arranged them in the order astronomical, geological, biological, psychological, sociological. Why this order? The reasons are obvious. If the Cosmos has been evolved, then, in order of time, astronomical phenomena preceded geological, geological preceded biological, biological preceded psychological, psychological preceded sociological. Equally was the arrangement dictated by order of dependence. The existence of each of these groups of phenomena made possible the existence of the succeeding group. I could not have put the groups in any other order without manifest derangement. The second half of the article first asks the question—Why does this universal transformation go on? and the alleged cause is that "every active force produces more than one change" or effect; the implication being that there is a continuous multiplication of effects, of which increasing heterogeneity is a result. The rest of the article traces out everywhere this multiplication of effects; and in thus interpreting deductively the previous inductions I was, of course, forced to follow the same succession of groups of phenomena by the necessities of orderly exposition.

Is there anything here attributable to M. Comte? This order of exposition, which arose irrespective of any classification of the sciences, Comtean or other, and which governs the order in which the works constituting the Synthetic Philosophy have been written, is one which Mr. Harrison is courageous enough to say corresponds with Comte's scheme of the sciences. He does this in face of the fact that of Comte's six sciences three have no place in it! It contains no di-

vision dealing with mathematics, none with physics, none with chemistry!

I pass on now to point out that six months after, in the second essay I named, there is recognized the fact that for this universal transformation of things there is a cause taking precedence of the multiplication of effects, namely, the instability of the homogeneous (i. e., the relatively homogeneous, for absolute homogeneity does not exist)—a law which holds alike of a nebulous mass, an ovum, a primitive tribe, etc. And then in the same essay the law of integration (previously recognized in 1855 in the "Principles of Psychology," Part III, chapter xiv), is set forth as holding of organisms and societies—a law later recognized as holding of all evolving aggregates, and eventually recognized as the primary trait of all evolution. Are these conceptions to be found in the Positive Philosophy?

Shortly after, further developments of these views took place, which are referred to in my letter to Mr. Mill already quoted. Then came recognition of the truth that in aggregates of all orders one of the traits of evolution is increase of definiteness; universally the tendency is for the differentiated parts, at first vaguely marked out, to become sharply marked out. Later still was recognized the fact that these various changes are accompanied everywhere by a process of segregation; and then, finally, in answer to the question, What is the outcome of all these changes? there was reached the answer—They inevitably continue till an equilibrium of forces is reached; every aggregate, inorganic or organic, goes on changing until the forces acting upon it are balanced by the forces it opposes to them; hence the general law of equilibration. Are these Comtean conceptions?

When in 1860–'62 "First Principles" was written, these several inductive and deductive generalizations were incorporated in a coherent theory; and in the chapter dealing with each, there was followed this same order in the groups of illustrations which I have shown naturally arises. Beyond this, however, there was an endeavor to go behind these proximate causes of the universal transformation, and find the ultimate cause. This was alleged to be the persistence of force (an expression I continue to use as comprehending both the conservation of energy and the constancy of those forces by which passive matter becomes known to us). Has Comte enunciated these ideas, or any allied to them?

Lastly, I have to point out that only in the reorganized second edition of "First Principles," published five years later, when, along with other developments, there was recognized that transformation of motion which everywhere accompanies the transformation of matter, did the general conception reach its complete form. There was a gradual growth, as Mr. Mill says; and it had continued from 1850 to 1867. Not only has Comte's influence no place whatever in this process, but the ultimate product of it has no alliance whatever with

the product he calls Positive Philosophy. For what is the one word which describes this theory of transformation, exhibited by the Cosmos as a whole and by every part of it, and proceeding everywhere after the same general manner and everywhere consequent on the same general laws of forces? The one word is Cosmogony. And what is the name applicable to M. Comte's Positive Philosophy? An Organon of the Sciences.

See, then, how the case stands. A system which had for its germinal idea Von Baer's formula of organic development—a system which grew by the addition of other general ideas, to one of which, I believe, Schelling's doctrine of individuation partially opened the way, but the others of which grew up I know not how—a system which slowly became a coherent whole, uniting the several principles by derivation from one ultimate principle—a system the exposition of which followed an order not determined by any theory of classification, but simply by the order of genesis of the phenomena themselves—a system which, at the very outset, presented itself as the rudiment of a cosmogony, and became eventually a fully-elaborated cosmogony; is a system which Mr. Harrison holds to be inspired by Comte's "Organon of the Sciences," the greater part of which is concerned with scientific methods, with the dependence of ideas, with the course of intellectual progress, with the order of discovery, and the like; and which entirely ignores geological evolution, biological evolution, and psychological evolution. This system it is which Mr. Harrison characterizes as "an attempt to play a new tune upon Comte's instrument"!

I ask space only for a few words on the question of authorities. Mr. Harrison, finding the verdict of Mr. John Stuart Mill against him, does his best to discredit it. He says that Mr. Mill was scarcely in a position for judging, since "he had one volume only and part of another before him." He is quite mistaken. If I had continued to quote Mr. Mill's letter, I should have quoted a passage saying that he had been re-reading the "Principles of Psychology" (edition of 1855). Besides this, and "Social Statics," and "First Principles," and nearly one volume of the Biology, he had before him two volumes of Essays, the majority of which bear in one way or other on the doctrine of evolution, and sufficiently show the drift of much that was coming. But Mr. Harrison attempts to discredit Mr. Mill's letter by calling it a "testimonial," and saying that he was able to "read between the lines." After having pointed out that I simply asked Mr. Mill to return my letter, and that his letter, accompanying it, was voluntarily written, I think every one will be of opinion that this sneer of Mr. Harrison's is wholly uncalled for; and when they observe that he says what he does notwithstanding that Mr. Mill, in his volume on Comte published a year later, utters substantially the same opinion as in his letter, they will think his sneer without excuse. To strengthen his case Mr. Harrison seeks to override the verdict of Mr. Mill by that of

Mr. Lewes—ranks Lewes higher than Mill as an authority in philosophy! I imagine the raised eyebrows of competent judges.

Here I leave the matter. I have nothing more to say than that if any one has doubts he may easily settle them, irrespective of the explanation I have given above, and irrespective of any authority. He will see that alike by its position as first of the series, and by its title, "First Principles" is shown to contain the cardinal ideas elaborated in the volumes following it. Let him, then, take this volume and take also Miss Martineau's abridged translation of the Positive Philosophy, and compare the two. After an hour's search for points of community he will, I think, feel astonished that any one should have asserted a connection between them.

I am, sir, your obedient servant,

HERBERT SPENCER.

ATHENÆUM CLUB, *September 13th.*

THE FUTURE OF THE NEGRO IN THE SOUTH.

BY JAMES B. CRAIGHEAD.

THE term "mud-sill" is supposed to be used contemptuously in the Southern States to designate the lowest rank of the people: those who use nothing and have nothing to use but muscle for their maintenance; men who are uneducated and indifferent to education; men without other aspiration or ambition than that which incites them to appease their hunger and to ward off the blasts of winter. Under every form of government, despotic, monarchal, or republican, such class, more or less depraved, must necessarily exist, and the question in the Southern States is, What shall be the color of the mud-sill? or, if the colors be assorted, white, black, and yellow, shall we have different orders of mud-sills based on colors? The position is open to competition, to all shades of color, to whichever is willing to take it, or most reluctant to strive for anything higher or better.

The Executive war decree of emancipation fell on the South at a time when, owing to the manly front presented by the Confederate forces, it was generally regarded by the Southern people as mere *brutum fulmen.* Even in cities which had succumbed to Federal arms, and were garrisoned by national troops, the proclamation was regarded by the citizens simply as a threat; these latter looked forward to a rapid advance of the Southern armies, and had no doubt of final victory. Hence they submitted to the increasing rebelliousness of their slaves, just as they submitted to the military requirements of post-officers, provosts, etc.—a mere temporary annoyance, not only soon to be got rid of, but to be heavily atoned for. In the sparsely settled rural regions the news came slowly, and was at first, to the ordinary

negro mind, incomprehensible; nevertheless, it gradually permeated his brain that, should the Federal arms prevail, he would be free. But would the North prevail? Every man in the circle of his acquaintance in whom had heretofore resided authority hooted at the idea; the possibility of the South being conquered was openly scouted, and the effect of this on the negro's intelligence was to warn him to submission. Here and there, one more adventurous than the rest ran away and hid himself behind the Federal lines, but ninety-nine out of a hundred not only remained in bondage, but openly ridiculed the idea of their preferring to be free: the old farm and the old master were good enough for them. Of these a small percentage were sincere, as was proved by their remaining at home and serving their former owners after the necessity for so doing had ceased, just as if no edict had been issued; but in time the last one deserted, even the octogenarians, who set up their separate establishments, when they could, with a parting declaration to their old masters that so long as they were able to support themselves they would do so, but after that they proposed to return and be maintained as were the aged in times of slavery.

To the unreflecting white man it seemed as if chaos had come again; nothing like this had ever before come under the limited range of his reading or experience. To the student it was but a repetition of history; to him, beyond the loss of so much personal property, and the delay in the readjustment of social laws, no great cataclysm had occurred or was to be apprehended. Before emancipation, the negro had to work or be lashed; now, he has to work or to starve. Before the war, the owner was obligated to furnish the slave with provisions and clothing, to pay his doctor's bills when sick, to maintain him in idleness when superannuated, to bury him when dead. Under the new *régime* the freedman must do all these things and make these provisions for himself. The intelligent Southern man was prepared to pocket his losses and to go to work under the new order of affairs, but was met at the very beginning with obstacles. The poor emancipated slave had an idea that liberty meant license: all his life he had seen free white people living a life of, what appeared to him, perfect idleness, and his thought was to reach that blissful condition: he was willing to labor only sufficiently to supply himself with meat and clothes, and it really appeared that the South, instead of selling, as it now does, the produce of a single crop to the value of over three hundred million dollars, would sink into a semi-barbarous condition, with a population (all the enterprising ones having removed) satisfied with just enough to prevent absolute want. And thus it might have been but for the *vim* and determination of the Anglo-Saxon people, who foresaw that, if but small crops were made, large prices would be obtained. Their example has told among the blacks, especially the men; the women have yet to learn; the example of white ladies, who lived luxuriously before the war, now doing a great part of their own

labor and drudgery, instead of being an example to the former slave women, only affords a gratification to their spite and malevolence.

The freedman imagined that whatever superiority white people have over the blacks is owing to education ; and as Eve was induced to think that if she and Adam should eat of the forbidden fruit they would be as gods, so the ordinary African thought if his child could only read, write, and cipher, he would be in every way the equal of the Caucasian. He was utterly unable to discriminate between a man with only capacity to fill with infinite labor a postal card and one who could reason out the law of gravity or define the principles of electricity. With this glorified idea on the subject of education, their enthusiastic desire for schools is not surprising. Their only idea of the difference between Prospero and Caliban was, that one could read and write and the other could not.

However absurd these views were, and however great the disappointment which follows, the result is good. If the entire race could read, write, and cipher, it would be an excellent thing. An utterly uneducated man, unless he chances to be of extraordinary acuteness, is at the mercy of one who is learned ; the latter may assert that twice twenty are fifty, and the ignorant man, unable to disprove the assertion, submits. Enough education to enable a laboring-man to calculate the amount of his wages, and to verify the entries and summing of his pass-book, is necessary to prevent his being cheated by unscrupulous men. A vast number of the colored people are now educated to that extent, with great advantage to the better understanding between employer and employé. If the latter can comprehend simple accounts, there will be little difficulty in the settlement of his wages ; but it is difficult to explain figures to the ignorant man, who, in most cases, imagines himself defrauded, simply because he can not comprehend. Persons who have to do with working-men, white or black, will readily agree that there is tenfold more trouble in adjusting accounts with those who are illiterate than with those who have even rudimental education.

The opportunities of the blacks for obtaining education in the South are abundant, greater, indeed, in many places than those in reach of the whites. In the State wherein the writer resides, each county is divided into school districts of convenient size, each with self-contained power of subdivision, under certain conditions : these districts are autonomous under general State laws ; they decide for themselves, by popular vote, the amount of tax they are willing to pay respectively for the purpose of education, which tax is collected by the revenue collector as other taxes are ; they elect each three directors to manage the scholastic affairs and funds, selection of teachers, etc. In vast numbers of these districts the blacks largely outnumber the whites, and elect not only magistrates, constables, etc., but also school directors, and in school matters the white element is utterly disregarded, except

in the matter of taxes. In the sparsely settled districts the amount of annual tax (limited to five mills) will permit of but one school, and that with a session of not more than four or five months each year, and herein lies the trouble. The black directors, knowing that but one school can be maintained, are willing to employ a white teacher and call it a white school provided their children are allowed to attend, or they will make it a black school, and white children may share the advantages. White prejudices, which none but a Southerner can understand or appreciate, render each of these offers unacceptable and repulsive, and it is difficult to blame the freedmen that they avail themselves of the power which the law has given them, and employ colored teachers. Things may be better regulated after a while; in the mean time the negroes are gradually acquiring education, while in many places the whites remain without schooling, or with but little.

If the African brain were as large and as active as that of the Caucasian, the result of this condition of affairs could be easily calculated, for, notwithstanding the preponderance of authority which centuries of domination have given to the white race, it is much to be doubted if the conditions would not be reversed if, with equal natural capacity, an educated colored race should oppose illiterate whites; but, fortunately for the latter, two things stand in the way of such absolute subversion of positions: First, it is indisputable that, as a race, the African is inferior to the Caucasian in intelligent comprehensive reasoning and constructive power, and it would require something besides mere intellectual improvement to bring the former up to the level of the latter. Second, the colored man has to-day a strong desire that his children shall be educated, though he is willing to make but few personal sacrifices for that object. To be sure, he votes taxes for the purpose, but, as he pays his proportion indirectly, he does not feel them. The desire is entirely predominated by his determination that they shall, at as early an age as possible, become workers, and thereby relieve his shoulders of a large part of his necessary labor. Consequently he is unwilling to allow much time to schools. So soon as the child is able to wield a hoe he is regarded a fractional field-hand, and during the cotton-picking season quite a large fraction. He knows nothing, it is not in his nature to know anything, of that vigorous Anglo-Saxon determination which, under the circumstances described, cheerfully pays the school-tax, and then makes personal sacrifices in order that the children may be sent to some pay-school. The desire of the African parent that his child shall work is so strong that it is safe to say that, with few exceptions, the young negroes of to-day, especially those on farms, live under more severe rules as to labor than their fathers did while children in slavery, with the reasonable consequence that the young African, as soon as he finds himself capable of self-support, quits forever the paternal roof which appears to him precisely as slavehood appeared to his ancestors.

Much has been written of late years concerning the condition of morality among the emancipated people, but little in extenuation thereof. During the existence of slavery, the status of married life among the blacks, especially among those of the rural districts, was much higher and more respectable than it is now. Slave-owners for sanitary and police reasons required a certain amount of conjugal fidelity. In all cases masters were consulted as to marriage alliances, and in most cases insisted that the ceremony should be performed in a public manner either by a magistrate or a minister of the gospel with all the formality that obtained among the whites. Conjugal fidelity was insisted on and enforced, if need be, by punishment. Man and wife finding themselves bound together by an indissoluble tie, did as the more intelligent of other races do, made the best of their bonds and lived harmoniously. This is all changed. After the war, the highest courts of the country decided that as matrimony is a civil contract and as slaves could not make legal contracts, *ergo*, no marriage entered into in a state of bondage was valid or could be enforced. The result of this correct but unfortunate decision was, that every former slave who lusted after a new and younger wife put aside the old one. The young married negroes, seeing this free-and-easy way of upsetting domestic arrangements, and without caring for the reason thereof, availed themselves of the first domestic quarrel to separate and select new partners. The newly separated, if continuing in the same neighborhood, did not of course marry other wives, but lived in concubinage; but, if they removed to other States, they did not hesitate to marry again. If the crime of bigamy were followed by sure punishment, there would not be penitentiaries enough in the South to hold the guilty of a single State. The colored people do not appear to see the viciousness of this condition of affairs; and the white people, grand juries included, do not care to take the matter up, and so it continues.

A great fault of the negro is a lack of veracity. It may be safely ventured that there is not a magistrate, judge, or lawyer in the South who will assert that the statements of negroes, especially of those out of cities, are to be relied upon. To be sure, there are many honorable exceptions, but it is a race characteristic. Many hesitate to tell a direct falsehood, but there are but few who will not lie constructively in concealing the truth. It is hard to condemn them. In times of slavery their only safety from deserved punishment was concealment and by lying out of the difficulty, assisted by the concurrent testimony of friends. The habit descends from father to child. The first lesson taught a colored child as soon as it is able to comprehend the lesson is, "If the white folks ask you anything, always answer, 'I don't know.'" Absolute ignorance, even if assumed, is safer than a manufactured lie. Often I have known a colored parent to chastise her child unmercifully for answering truthfully some simple question

of no importance whatever, only that it was a white person who was the questioner. These parents will not learn that a child taught systematically to lie to others will lie to them, and any detected prevarication with them is in the same way cruelly punished; and, as the ignorant never punish except when in a rage, it is safe to say that the life of the young darkey is not a pleasant one.

The peculiarities and monstrosities of African religion (so called) have been too often described to require many words here. In the cant of the present time, a number of Protestant denominations, each at war with the others, assume and allow to the others the title "orthodox." It is difficult for a layman to understand how twenty different bodies all teaching different faiths can all be orthodox, but so it is, and under this ruling the various African churches are all orthodox. How far are the vices, described as appertaining to the race, modified by religion? Not much. With the ordinary African religion is not a matter of doing, but entirely a matter of feeling. If one of them, after spending an entire week in vicious living, can only get up a certain amount of enthusiastic feeling during the shouting, howling, and dancing of a Sunday-night meeting, he feels that his soul is washed and that it is spotless as snow. It is the same ratiocination that convinces every convicted negro murderer that he will ascend directly from the gallows into heaven. Other more phlegmatic sinners may be compelled to wait for the judgment-day, but for him the gates of heaven stand wide open. When pardon follows sin so rapidly, it is not to be wondered at that he is ready to fall again to-morrow.

What has been written of the African people in this paper has in view those who live in the country and have but limited intercourse with minds superior to their own; a class of people who, if left to themselves, would degenerate rapidly into barbarism. But for the small leaven of more intelligent whites, the black people would soon be victims of *voudoo.* Indeed, it is hard to find a rural community in the South where that dreadful bugbear is not more or less believed in and feared. Often a stupid, uneducated negro secretly dominates an entire neighborhood by virtue of a self-assertion that he possesses mystic powers, and an obscure hint of a dirty little bag of miscellaneous abominations carries far more terror than ever did overseer's whip. I may defy the magician's power and openly submit myself to his supernatural malevolence, but it will do but little toward assuaging the fears of the negroes, who agree that the spells have no power over another race.

I have never had the craze of enforced education or enforced temperance; all the same, I shall be glad to see the colored people as well as the whites educated: not in high-schools, with a view of deluging the country with school-teachers, but to the extent of giving every child a good common-school education. In my official character as school director (to which office I was once elected simply because

there were but two colored men in the district who could read and write, and the law requires three officers), I have received a number of written applications for the position as teacher, some from graduates of normal schools and universities (?), all with examiners' certificates of ability, etc., but I do not remember seeing any one of these applications which was grammatically expressed or orthographically correct. Still, as the applicants were capable of teaching the rudiments of education, these trifling defects were never permitted to stand in the way of their employment. It is not asserted that all the graduates of these normal schools and universities are equally deficient; it is quite probable that the better sort find places in cities, while the country must content itself with what is left.

The social problem in the South does not so immediately concern the wealthy as it does the poor whites. The rich man can send his children to academies and colleges; he can seek society wherever it is congenial; but the poor man, tied to one spot, must be governed by circumstances beyond his control. At present the poor white and black people work together in the fields and shops and live on friendly terms without hitch or jar until the white asserts in some way his feeling of superiority, which, both being equal in means, education, and political power, is based on nothing more substantial than the mere color of the skin. Then the negro stands on his dignity, and is ready for combat. In peaceful neighborhoods, there is but little assumption of superiority, and it is only manifested in a silent way by the steady refusal of the white to permit his children to sit at school or in church with the children of the black; they may play together, work together, and treat each other as equals, until church or school is mentioned, and there the line is drawn. So long as this passive ostracism works his children no absolute evil, the negro, with his own schools and his own churches, cares nothing for it. It is perhaps vain speculation as to the future of this problem; only it seems certain that if the white children are not educated and taught refinements, and the black children are, it will be difficult in the future, even if desirable, to maintain any distinction of classes in the South, and especially any favorable distinction, which will be based on nothing more substantial than the absence of color in the epidermis, unless African nature is irredeemably bad; unless the vicious qualities attributed to him in this paper are irreparable, it is absolutely certain that, with the aids which now surround him, he will rise greatly in the scale of humanity, and a generous world will show its favor to the intelligent individual, no matter how black his skin, who has lifted himself out of the mire and contempt of centuries, rather than extend a helping hand to one who has had the fortune to be born of a higher race, but who proved unworthy of his lot.

Scientists and the world admit the natural superiority of the white races over the colored, and it seems incontrovertible that, with equal

ambition and equal excitement to exertion, the white will surely surpass the black in any and every condition of life, and in the exercise of every function of mind and muscle; and there can be no political chain strong enough to bind the white in a subordinate position, provided he will avail himself of the advantages which Nature has given him in the division of the races of humanity.

PENDING PROBLEMS OF ASTRONOMY.*

By Professor CHARLES A. YOUNG.

MR. PRESIDENT, Fellows and Members of the Association, Ladies and Gentlemen: Thirty-six years ago this very month, in this city, and near the place where we are now assembled, the American Association for the Advancement of Science was organized, and held its first meeting. Now, for the first time, it revisits its honored birthplace.

Few of those present this evening were, I suppose, in attendance upon that first meeting. Here and there, among the members of the Association, I see, indeed, the venerable faces of one and another, who, at that time in the flush and vigor of early manhood, participated in its proceedings and discussions; and there are others, who, as boys or youths, looked on in silence, and listening to the words of Agassiz and Peirce, of Bache and Henry, and the Rogers brothers and their associates, drank in that inspiring love of truth and science which ever since has guided and impelled their lives. Probably enough, too, there may be among our hosts in the audience a few who remember that occasion, and were present as spectators.

But, substantially, we who meet here to-day are a new generation, more numerous certainly, and in some respects unquestionably better equipped for our work, than our predecessors were; though we might not care to challenge comparisons as regards native ability, or clearness of insight, or lofty purpose.

And the face of Science has greatly changed in the mean time—as much, perhaps, as this great city and the nation. One might almost say that, since 1848, "all things have become new" in the scientific world. There is a new mathematics and a new astronomy, a new chemistry and a new electricity, a new geology and a new biology. Great voices have spoken, and have transformed the world of thought and research as much as the material products of science have altered the aspects of external life. The telegraph and dynamo-machine have

* Address of the retiring President of the American Association for the Advancement of Science, delivered at Philadelphia, September 5, 1884.

not more changed the conditions of business and industry than the speculations of Darwin and Helmholtz, and their compeers, have affected those of philosophy and science.

But, although this return to our birthplace suggests retrospections and comparisons which might profitably occupy our attention for even a much longer time than this evening's session, I prefer, on the whole, to take a different course ; looking forward rather than backward, and confining myself mainly to topics which lie along my own line of work.

The voyager upon the inland Sea of Japan sees continually rising before him new islands and mountains of that fairy-land. Some come out suddenly from behind nearer rocks or islets, which long concealed the greater things beyond ; and some are veiled in clouds which give no hint of what they hide, until a breeze rolls back the curtain ; some, and the greatest of them all, are first seen as minute specks upon the horizon, and grow slowly to their final grandeur. Even before they reach the horizon-line, while yet invisible, they sometimes intimate their presence by signs in sky and air ; so slight, indeed, that only the practiced eye of the skillful sailor can detect them, though quite obvious to him.

Somewhat so, as we look forward into the future of a science, we see new problems and great subjects presenting themselves. Some are imminent and in the way—they must be dealt with at once, before further progress can be made ; others are more remotely interesting in various degrees ; and some as yet are mere suggestions, almost too misty and indefinite for steady contemplation.

With your permission, I propose this evening to consider some of the pending problems of astronomy—those which seem to be most pressing, and most urgently require solution as a condition of advance ; and those which appear in themselves most interesting or likely to be fruitful from a philosophic point of view.

Taking first those that lie nearest, we have the questions which relate to the dimensions and figure of the earth, the uniformity of its diurnal rotation, and the constancy of its poles and axis. I think the impression prevails that we already know the earth's dimensions with an accuracy even greater than that required by any astronomical demands. I certainly had that impression myself not long ago, and was a little startled on being told by the superintendent of our "Nautical Almanac" that the remaining uncertainty was still sufficient to produce serious embarrassment in the reduction and comparison of certain lunar observations. The length of the line joining, say, the Naval Observatory at Washington with the Royal Observatory at the Cape of Good Hope is doubtful, not to the extent of only a few hundred feet, as commonly supposed, but the uncertainty amounts to some thousands of feet, and may possibly be a mile or more—probably not less than a ten-thousandth of the whole distance ; and the direction of the

line is uncertain in about the same degree. Of course, on those portions of either continent which have been directly connected with each other by geodetic triangulations, no corresponding uncertainty obtains; and as time goes on, and these surveys are extended, the form and dimensions of each continuous land-surface will become more and more perfectly determined. But, at present, we have no satisfactory means of obtaining the desired accuracy in the relative position of places separated by oceans, so that they can not be connected by chains of triangulation. Astronomical determinations of latitude and longitude do not meet the case; since, in the last analysis, they only give at any selected station the *direction of gravity* relative to the axis of the earth, and some fixed meridian plane, and do not furnish any *linear* measurement or dimension.

Of course, if the surface of the earth were an exact spheroid, and if there were no irregular attractions due to mountains and valleys, and the varying density of strata, the difficulty could be easily evaded; but, as the matter stands, it looks as if nothing short of a complete geodetic triangulation of the whole earth would ever answer the purpose—a triangulation covering Asia and Africa, as well as Europe, and brought into America by way of Siberia and Behring's Straits.

It is, indeed, theoretically possible, and just conceivable, that the problem may some day be reversed, and that the geodesist may come to owe some of his most important data to the observers of the lunar motions. When the relative position of two or more remote observatories shall have been precisely determined by triangulation (for instance, Greenwich, Madras, and the Cape of Good Hope), and when, by improved methods and observations made at these fundamental stations, the moon's position and motion relative to them shall have been determined with an accuracy much exceeding anything now attainable, then by similar observations, made simultaneously at any station in this hemisphere, it will be theoretically possible to determine the position of this station, and so, by way of the moon, to bridge the ocean, and ascertain how other stations are related to those which were taken as primary. I do not, of course, mean to imply that, in the *present state* of observational astronomy, any such procedure would lead to results of much value; but, before the Asiatic triangulation meets the American at Behring's Straits, it is not unlikely that the accuracy of lunar observations will be greatly increased. The present uncertainty as to the earth's dimensions is, however, a sensible embarrassment to astronomers, only in dealing with the moon, especially in attempting to employ observations made at remote and ocean-separated stations for the determination of her parallax.

As to the form of the earth, it seems pretty evident that before long it will be wise to give up further attempts to determine exactly what spheroid or ellipsoid *most nearly corresponds* to the actual figure of the earth; since every new continental survey will require a modi-

fication of the elements of this spheroid in order to take account of the new data. It will be better to assume some closely approximate spheroid as a finality; its elements to be forever retained unchanged, while the deviations of the actual surface from this ideal standard will be the subject of continued investigation and measurement.

A more important and anxious question of the modern astronomer is, Is the earth's rotation uniform, and, if not, in what way and to what extent does it vary? The importance, of course, lies in the fact that this rotation furnishes our fundamental measure and unit of time. Up to a comparatively recent date there has not been reason to suspect this unit of any variation sufficient to be detected by human observation. It has long been perceived, of course, that any changes in the earth's form or dimensions must alter the length of the day. The displacement of the surface or strata by earthquakes or by more gradual elevation and subsidence, the transportation of matter toward or from the equator by rivers or ocean-currents, the accumulation or removal of ice in the polar regions or on mountain-tops—any such causes must necessarily produce a real effect. So, also, must the friction of tides and trade-winds. But it has been supposed that these effects were so minute, and to such an extent mutually compensatory, as to be quite beyond the reach of observation; nor is it yet certain that they are not. All that can be said is, that it is now beginning to be *questionable* whether they are, or are not.

The reason for suspecting perceptible variation in the earth's revolution lies mainly in certain unexplained irregularities in the apparent motions of the Moon. She alone, of all the heavenly bodies, changes her place in the sky so rapidly that minute inaccuracies of a second or two in the time of observation would lead to sensible discrepancies in the observed position; an error of one second in the time, corresponding to about half a second in her place—a quantity minute, certainly, but perfectly observable. No other heavenly body has an apparent movement anywhere nearly as rapid, excepting only the inner satellite of Mars; and this body is so minute that its accurate observation is impracticable, except with the largest telescopes, and at the times when Mars is unusually near the Earth.

Now, of late, the motions of the Moon have been very carefully investigated, both theoretically and observationally; and, in spite of everything, there remain discrepancies which defy explanation. We are compelled to admit one of three things: either the lunar theory is in some degree mathematically incomplete, and fails to represent accurately the gravitational action of the earth and sun and other known heavenly bodies, upon her movements; or some unknown force other than the gravitational attractions of these bodies is operating in the case; or else, finally, the earth's rotational motion is more or less irregular, and so affects the time-reckoning and confounds prediction. If the last is really the case, it is in some sense a most discouraging

fact, necessarily putting a limit to the accuracy of all prediction, until some other unchanging and convenient measure of time shall be found to replace the "day" and "second."

The question at once presents itself, How can the constancy of the day be tested? The lunar motions furnish grounds of suspicion, but nothing more; since it is at least as likely that the mathematical theory is minutely incorrect or incomplete as that the day is sensibly variable. Up to the present time the most effective tests suggested are from the transits of Mercury and from the eclipses of Jupiter's satellites. On the whole, the result of Professor Newcomb's elaborate and exhaustive investigation of all the observed transits, together with all the available eclipses and occultations of stars, tends rather to establish the sensible constancy of the day, and to make it pretty certain (to use his own language) that "inequalities in the lunar motions, "not accounted for by the theory of gravitation, really exist, and in "such a way that the mean motion of the moon between 1800 and 1875 "was really less (i. e., slower) than between 1720 and 1800." Until lately, the observations of Jupiter's satellites have not been made with sufficient accuracy to be of any use in settling so delicate a question; but at present the observation of their eclipses is being carried on at Cambridge, Massachusetts, and elsewhere, by methods that promise a great increase of accuracy over anything preceding. Of course, no speedy solution of the problem is possible through such observations, and their result will not be so free from mathematical complications as desirable—complications arising from the mutual action of the satellites and the ellipsoidal form of the planet. On account of its freedom from all sensible disturbances, the remote and lonely satellite of Neptune may possibly some time contribute useful data to the problem.

We have not time, and it lies outside my present scope, to discuss whether, and, if so, how, it may be possible to find units of time and length which shall be independent of the earth's conditions and dimensions, free from all *local considerations*, cosmical, and as applicable in the planetary system of the remotest star as in our own. At present we can postpone its consideration; but the time must unquestionably come when the accuracy of scientific observation will be so far increased that the irregularities of the earth's rotation, produced by the causes alluded to a few minutes ago, will protrude and become intolerable. Then a new unit of time will have to be found for scientific purposes, founded, perhaps, as has been already suggested by many physicists, upon the vibrations or motion of light, or upon some other physical action which pervades the universe.

Another problem of terrestrial astronomy relates to the constancy of the position of the earth's axis in the globe. Just as displacements of matter upon the surface or in the interior of the earth would produce changes in the time of rotation, so also would they cause corre-

sponding alterations in the position of the axis and in the places of the poles—changes certainly very minute. The only question is, Whether they are so minute as to defy detection. It is easy to see that any such displacements of the earth's axis will be indicated by changes in the *latitudes* of our observatories. If, for instance, the pole were moved a hundred feet from its present position, toward the Continent of Europe, the latitudes of European observatories would be increased about one second, while in Asia and America the effects would be trifling. The only observational evidence of such movements of the pole, which thus far amounts to anything, is found in the results obtained by Nyren in reducing the determinations of the latitude of Pulkowa, made with the great vertical circle, during the last twenty-five years. They seem to show a slow, steady diminution of the latitude of this observatory, amounting to about a second in a century; as if the north pole were drifting away, and increasing its distance from Pulkowa at the rate of about one foot a year. The Greenwich and Paris observations do not show any such result; but they are not conclusive, on account of the difference of longitude, to say nothing of their inferior precision.

The question is certainly a doubtful one; but it is considered of so much importance that, at the meeting of the International Geodetic Association in Rome last year, a resolution was adopted recommending observations specially designed to settle it. The plan of Signor Fergola, who introduced the resolution, is to select pairs of stations, having nearly the same latitude, but differing widely in longitude, and to determine the *difference* of their latitudes by observations of the same set of stars, observed with similar instruments, in the same manner, and reduced by the same methods and formulæ. So far as possible, the same observers are to be retained through a series of years, and are frequently to exchange stations when practicable, so as to eliminate personal equations. The main difficulty of the problem lies, of course, in the minuteness of the effect to be detected; and the only hope of success lies in the most scrupulous care and precision in all the operations involved.

Other problems, relating to the rigidity of the earth and its internal constitution and temperature, have, indeed, astronomical bearings, and may be reached to some extent by astronomical methods and considerations; but they lie on the border of our science, and time forbids anything more than their mere mention here.

If we consider next the problems set us by the Moon, we find them numerous, important, and difficult. A portion of them are purely mathematical, relating to her orbital motion; while others are physical, and have to do with her surface, atmosphere, heat, etc. As has been already intimated, the lunar theory is not in a satisfactory state. I do not mean, of course, that the moon's deviations from the predicted path are gross and palpable—such, for instance, as could be perceived

by the unaided eye (this I say for the benefit of those who otherwise might not understand what "pernickity" creatures astronomers are); but they are large enough to be easily observable, and even obtrusive, amounting to several seconds of arc, or miles of space. As we have seen, the attempt to account for them by the irregularity of the earth's rotation has apparently failed; and we are driven to the conclusion, either that other forces than gravitation are operative upon the lunar motions, or else (what is far more probable, considering the past history of theoretical astronomy) that the mathematical theory is somewhere at fault.

To one looking at the matter a little from the outside it seems as if that which is most needed just now, in order to secure the advance of science in many directions, is a new, more comprehensive, and more manageable solution of the fundamental equations of motion under attraction. Far be it from me to cry out against those mathematicians who delight themselves in transcendental and n-dimensional space, and revel in the theory of numbers—we all know how unexpectedly discoveries and new ideas belonging to one field of science find use and application in widely different regions—but I own I feel much more interest in the study of the theory of functions and differential equations, and expect more aid for astronomy from it.

The problem of any number of bodies, moving under their mutual attraction, according to the Newtonian laws, stands, from á physical point of view, on precisely the same footing as that of *two* bodies. Given the masses, and the positions and velocities corresponding to any moment of time, then the whole configuration of the system for all time, past and future (abstracting outside forces, of course), is absolutely determinate, and amenable to calculation. But while, in the case of *two* bodies, the calculation is easy and feasible, by methods known for two hundred years, our analysis has not yet mastered the general problem for more than two. In special instances, by computations, tedious, indirect, and approximate, we can, indeed, carry our predictions forward over long periods, or indicate past conditions with any required degree of accuracy; but a general and universally practicable solution is yet wanting. The difficulties in the way are purely mathematical; a step needs to be taken, corresponding in importance to the introduction of the circular functions into trigonometry, the invention of logarithms, or the discovery of the calculus. The problem confronts the astronomer on a hundred different roads; and, until it is overcome, progress in these directions must be slow and painful. One could not truly say, perhaps, that the lunar theory must, in the mean while, remain quite at a stand-still: labor expended in the old ways, upon the extension and development of existing methods, may not be fruitless, and may, perhaps, after a while, effect the reconcilement of prediction and observation far beyond the present limits of accuracy. But if we only had the mathematical powers we long for,

then progress would be as by wings: we should fly, where now we crawl.

As to the physical problems presented by the moon, the questions relating to the light and heat—the radiant energy—it sends us, and to its temperature, are the most attractive at present, especially for the reason that the results of the most recent investigators seem partially to contradict those obtained by their predecessors some years ago. It now looks as if we should have to admit that nearly all we receive from the moon is simply *reflected* radiation, and that the temperature of the lunar surface nowhere rises as high as the freezing-point of water, or even of mercury. At the same time, some astronomers of reputation are not disposed to admit such an upsetting of long-received ideas; and it is quite certain that, in the course of the next few years, the subject will be carefully and variously investigated. Closely connected with this is the problem of a lunar atmosphere—if, indeed, she has any.

Then there is the very interesting discussion concerning changes upon the moon's surface. Considering the difference between our modern telescopes and those employed fifty or a hundred years ago, I think it still far from certain that the differences between the representations of earlier and later observers necessarily imply any real alterations. But they, no doubt, render it more or less probable that such alterations have occurred, and are still in progress; and they justify a persistent, careful, minute, and thorough study of the details of the lunar surface with powerful instruments: especially do they inculcate the value of large-scale photographs, which can be preserved for future comparison as unimpeachable witnesses.

I will not leave the moon without a word in respect to the remarkable speculations of Professor George Darwin concerning the tidal evolution of our satellite. Without necessarily admitting all the numerical results as to her age and her past and future history, one may certainly say that he has given a most plausible and satisfactory explanation of the manner in which the present state of things might have come about through the operation of causes known and recognized, has opened a new field of research, and shown the way to new dominions. The introduction of the doctrine of the conservation of energy, as a means of establishing the conditions of motion and configuration in an astronomical system, is a very important step.

In the Planetary system we meet, in the main, the same problems as those that relate to the moon, with a few cases of special interest. For the most part the accordance between theory and observation in the motions of the larger planets is as close as could be expected. The labors of Leverrier, Hill, Newcomb, and others, have so nearly cleared the field that it seems likely that several decades will be needed to develop discrepancies sufficient to furnish any important corrections to our present tables. Leverrier himself, however, indicated one strik-

ing and significant exception to the general tractableness of the planets. Mercury, the nearest to the sun, and the one, therefore, which ought to be the best behaved of all, is rebellious to a certain extent; the perihelion of its orbit moves around the sun more rapidly than can be explained by the action of the other known planets. The evidence to this effect has been continually accumulating ever since Leverrier first announced the fact, some thirty years ago; and the recent investigation by Professor Newcomb, of the whole series of observed transits, puts the thing beyond question. Leverrier's own belief (in which he died) was, that the effect is due to an unknown planet or planets between Mercury and the sun; but, as things now stand, we think that any candid investigator must admit that the probability of the existence of any such body or bodies of considerable dimensions is vanishingly small. We do not forget the numerous instances of round spots seen on the solar disk, nor the eclipse-stars of Watson, Swift, Trouvelot, and others; but the demonstrated possibility of error or mistake in all these cases, and the tremendous array of negative evidence from the most trustworthy observers, with the best equipment and opportunity, make it little short of certain that there is no Vulcan in the planetary system.

A ring of meteoric matter between the planet and the sun might account for the motion of the perihelion; but, as Newcomb has suggested, such a ring would also disturb the *nodes* of Mercury's orbit. It has been surmised that the cause may be something in the distribution of matter within the solar globe, or some variation in gravitation from the exact law of the inverse square, or some supplementary electric or magnetic action of the sun, or some special effect of the solar radiation, sensible on account of the planet's proximity, or something peculiar to the region in which the planet moves; but thus far no satisfactory explanation has been established.

Mercury as yet defies all our attempts to ascertain the length of its day and the character and condition of its surface. Apparently the instruments and methods now at command are insufficient to cope with the difficulties of the problem; and it is not easy to say how it can be successfully attacked.

With Venus, the earth's twin-sister, the state of things is a little better: we do already know, with some degree of approximation, her period of rotation; and the observations of the last few months bid fair, if followed up, to determine the position of her poles, and possibly to give us some knowledge of her mountains, continents, and seas.

It would be rash to say of Mars that we have reached the limit of possible knowledge as regards a planet's surface; but the main facts are now determined, and we have a rather surprising amount of supposed knowledge regarding his geography. By "supposed" I mean merely to insinuate a modest doubt whether some of the map-makers

have not gone into a little more elaborate detail than the circumstances warrant. At any rate, while the "areographics" agree very well with each other in respect to the planet's more important features, they differ widely and irreconcilably in minor points.

Of the asteroids there is but little to be said. We are rather reluctantly obliged to admit that it is a part of our scientific duty as astronomers to continue to search for the remaining members of the group, although the family has already become embarrassingly large. Still, I think we are likely to learn as much about the constitution, genesis, and history of the solar system from these little flying rocks as from their larger relatives ; and the theory of perturbations will be forced to rapid growth in dealing with the effects of Jupiter and Saturn upon their motions. Nor is it unlikely that some day the hunter for this small game may be rewarded by the discovery of some great world, as yet unknown, slow moving in the outer desolation beyond the remotest of the present planetary family. Some configurations in certain cometary orbits and some almost evanescent peculiarities in Neptune's motions have been thought to point to the existence of such a world ; and there is no evidence, nor even a presumption, against it.

As regards the physical features of the asteroids we at present know practically nothing : the field is absolutely open. Whether it is worth anything may be a question ; and yet, if one *could* reach it, I am persuaded that a knowledge of the substance, form, density, rotation, temperature, and other physical characteristics, of one of these little vagabonds would throw vivid light on the nature and behavior of interplanetary space, and would be of great use in establishing the physical theory of the solar system.

The planet Jupiter, lordliest of them all, still, as from the first, presents problems of the highest importance and interest. A sort of connecting link between suns and planets, it seems as if, perhaps, we might find, in the beautiful and varied phenomena he exhibits, a kind of half-way house between familiar terrestrial facts and solar mysteries. It seems quite certain that no analogies drawn from the earth and the earth's atmosphere alone will explain the strange things seen upon his disk, some of which, especially the anomalous differences observed between the rotation periods derived from the observation of markings in different latitudes, are very similar to what we find upon the sun. "The great red spot" which has just disappeared, after challenging for several years our best endeavors to understand and explain it, still, I think, remains as much a mystery as ever—a mystery probably hiding within itself the master-key to the constitution of the great orb of whose inmost nature it was an outward and most characteristic expression. The same characteristics are also probably manifested in other less conspicuous but equally curious and interesting markings on the varied and ever-changing countenance of this planet ; so

that, like the Moon, it will well repay the most minute and assiduous study.

Its satellite system deserves careful observation, especially in respect to the eclipses which occur; since we find in them a measure of the time required for light to cross the orbit of the earth, and so of the solar parallax, and also because, as has been already mentioned, they furnish a test of the constancy of the earth's rotation. The photometric method of observing these eclipses, first instituted by Professor Pickering at Cambridge in 1878, and since reinvented by Cornu in Paris, has already much increased the precision of the results. With reference to the mathematical theory of the motion of these satellites, the same remarks apply as to the planetary theory. As yet nothing appears in the problem to be beyond the power and scope of existing methods, when carried out with the necessary care and prolixity; but a new and more compendious method is most desirable.

The problems of Saturn are much the same as those of Jupiter, excepting that the surface and atmospheric phenomena are less striking, and more difficult of observation. But we have, in addition, the wonderful rings, unique in the heavens, the loveliest of all telescopic objects, the type and pattern, I suppose, of world-making, in actual progress before our eyes. There seems to be continually accumulating evidence from the observations of Struve, Dawes, Henry, and others, that these whirling clouds are changing in their dimensions and in the density of their different parts; and it is certainly the duty of every one who has a good telescope, a sharp eye, and a chastened imagination, to watch them carefully, and set down exactly what he sees. It may well be that even a few decades will develop most important and instructive phenomena in this gauzy girdle of old Chronos. Great care, however, is needed in order not to mistake fancies and illusions for solid facts. Not a few anomalous appearances have been described and commented on, which failed to be recognized by more cautious observers with less vivid imaginations, more trustworthy eyes, and better telescopes.

The outer planets, Uranus and Neptune, until recently, have defied all attempts to study their surface and physical characteristics. Their own motions and those of their satellites have been well worked out; but it remains to discuss their rotation, topography, and atmospheric peculiarities. So remote are they, and so faintly illuminated, that the task seems almost hopeless; and yet, within the last year or two, some of our great telescopes have revealed faint and evanescent markings upon Uranus, which may in time lead to further knowledge of that far-off relative. Perhaps the telescope of the future will give us some such views of Neptune as we now get of Jupiter.

There is a special reason for attempts to determine the rotation periods of the planets, in the fact that there is very possibly some connection between these periods, on the one hand, and, on the other, the

planets' distances from the sun, their diameters and masses. More than thirty years ago, Professor Kirkwood supposed that he had discovered the relation in the analogy which bears his name. The materials for testing and establishing it were then, however, insufficient, and still remain so, leaving far too many of the data uncertain and arbitrary. Could such a relation be discovered, it could hardly fail to have a most important significance with respect to theories of the origin and development of the planetary system.

The great problem of the absolute dimensions of our system is, of course, commanded by the special problem of the solar parallax; and this remains a problem still. Constant errors of one kind or another, the origin of which is still obscure, seem to affect the different methods of solution. Thus, while experiments upon the velocity of light and heliometric measurements of the displacements of Mars among the stars agree remarkably in assigning a smaller parallax (and greater distance of the sun) than seems to be indicated by the observations of the late transits of Venus, and by methods founded on the lunar motions, on the other hand, the meridian observations of Mars all point to a larger parallax and smaller distance. While still disposed to put more confidence in the methods first named, I, for one, must admit that the margin of probable error seems to me to have been rather increased than diminished by the latest published results deduced from the transits. I do not feel so confident of the correctness of the value 8·80″ for the solar parallax as I did three years ago. In its very nature, this problem is one, however, that astronomers can never have done with. So fundamental is it, that the time will never come when they can properly give up the attempt to increase the precision of their determination, and to test the received value by every new method that may be found.

The problems presented by the Sun alone might themselves well occupy more than the time at our disposal this evening. Its mass, dimensions, and motions, as a whole, are, indeed, pretty well determined and understood; but when we come to questions relating to its constitution, the cause and nature of the appearances presented upon its surface, the periodicity of its spots, its temperature, and the maintenance of its heat, the extent of its atmosphere, and the nature of the corona, we find the most radical differences of opinion.

The difficulties of all solar problems are, of course, greatly enhanced by the enormous difference between solar conditions and the conditions attainable in our laboratories. We often reach, indeed, similarity sufficient to establish a bond of connection, and to afford a basis for speculation; but the dissimilarity remains so great as to render quantitative calculations unsafe, and make positive conclusions more or less insecure. We can pretty confidently infer the presence of iron and hydrogen and other elements in the sun by appearances which we can reproduce upon the earth; but we can not safely apply empirical formulæ (like that of Dulong and Petit, for instance), de-

duced from terrestrial experiments, to determine solar temperatures: such a proceeding is an unsound and unwarrantable extrapolation, likely to lead to widely erroneous conclusions.

For my own part, I feel satisfied as to the substantial correctness of the generally received theory of the sun's constitution, which regards this body as a great ball of intensely heated vapors and gases, clothed outwardly with a coat of dazzling clouds formed by the condensation of the less volatile substances into drops and crystals like rain and snow. Yet it must be acknowledged that this hypothesis is called in question by high authorities, who maintain, with Kirchhoff and Zöllner, that the visible photosphere is no mere layer of clouds, but either a solid crust, or a liquid ocean of molten metals; and there may be some who continue to hold the view of the elder Herschel (still quoted as authoritative in numerous school-books), that the central core of the sun is a solid and even habitable globe, having the outer surface of its atmosphere covered with a sheet of flame maintained by some action of the matter diffused in the space through which the system is rushing. We must admit that the question of the sun's constitution is not yet beyond debate. And not only the constitution of the sun itself, but the nature and condition of the matter composing it, is open to question. Have we to do with iron and sodium and hydrogen as we know them on the earth, or are the solar substances in some different and more elemental state?

However confident many of us may be as to the general theory of the constitution of the sun, very few, I imagine, would maintain that the full explanation of sun-spots and their behavior has yet been reached. We meet continually with phenomena which, if not really contradictory to prevalent ideas, at least do not find in them an easy explanation. So far as mere visual appearances are concerned, I think it must be conceded that the most natural conception is that of a dark chip or scale thrown up from beneath, like scum in a caldron, and floating, partly submerged, in the blazing flames of the photosphere which overhang its edges, and bridge across it, and cover it with filmy veils, until at last it settles down again and disappears. It hardly *looks* like a mere hollow filled with cooler vapor, nor is its appearance that of a cyclone seen from above. But then, on the other hand, its spectrum under high dispersion is very peculiar; not at all that of a solid, heated slag, but it is made up of countless fine dark lines, packed almost in contact, showing, however, here and there, a bright line, or at least an interspace where the rank is broken by an interval wider than that which elsewhere separates the elementary lines—a spectrum which, so far as I know, has not yet found an analogue in any laboratory experiment. It seems, however, to belong to the type of absorption spectra, and to indicate, as the accepted theory requires, that the spot is dark in consequence of *loss* of light, and not from any original defect of luminosity. Here, certainly, are problems that require solution.

The problem of the sun's peculiar rotation and equatorial acceleration appears also a most important one, and is still unsolved. Probably its solution depends in some way upon a correct understanding of the exchanges of matter going on between the interior and the surface of the fluid, cooling globe. It is a significant fact (already alluded to) that a similar relation appears to hold upon the disk of Jupiter ; the bright spots near the equator of the planet completing their rotation about five minutes more quickly than the great red spot which was forty degrees from the equator. It is hardly necessary to say that an astronomer, watching our terrestrial clouds from some external station (on the Moon, for instance), would observe just the reverse. On the Earth, equatorial clouds complete their revolution *more slowly* than those in our own latitude. *Our* storms travel toward the east, while the volcanic dust from Krakatoa moved swiftly west. We may at least conjecture that the difference between different planets somehow turns upon the question whether the body whose atmospheric currents we observe is receiving more heat from without than it is throwing off itself. Whatever may be the true explanation of this peculiarity in the motion of sun-spots, it will, when reached, probably carry with it the solution of many other mysteries, and will arbitrate conclusively between rival hypotheses.

The periodicity of the sun-spots suggests a number of important and interesting problems ; relating, on the one hand, to its mysterious cause, and, on the other, to the possible effects of this periodicity upon the earth and its inhabitants. I am no "sun-spottist" myself, and am very doubtful whether the terrestrial influence of sun-spots amounts to anything worth speaking of, except in the direction of magnetism. But all must concede, I think, that this is by no means yet demonstrated (it is not easy to prove a negative) ; and there certainly are facts and presumptions enough tending the other way to warrant more extended investigation of the subject. The investigation is embarrassed by the circumstance, pointed out by Dr. Gould, that the effects of sun-spot periodicity, if they exist at all (as he maintains they do), are likely to be quite different in different portions of the earth. The influence of changes in the amount of the solar radiation will, he says, be first and chiefly felt in alterations and deflections of the prevailing winds, thus varying the *distribution* of heat and rain upon the surface of the earth, without necessarily much changing its *absolute amount.* In some regions it may, therefore, be warmer and drier during a sun-spot maximum, while in adjoining countries it is the reverse.

There can be no question that it is now one of the most important and pressing problems of observational astronomy to devise apparatus and methods delicate enough to enable the student to follow promptly and accurately the presumable changes in the daily, even the hourly, amounts of the solar radiation. It might, perhaps, be possible even

with existing instruments, to obtain results of extreme value from observations kept up with persistence and scrupulous care for several years at the top of some rainless mountain, if such can be found; but the undertaking would be a difficult and serious affair, quite beyond any private means.

Related to this subject is the problem of the connection between the activity of the solar surface and magnetic disturbances on the earth—a connection unquestionable as matter of fact, but at present unexplained as matter of theory. It may have something to do with the remarkable prominence of iron in the list of solar materials; or the explanation may, perhaps, be found in the mechanism by means of which the radiations of light and heat traverse interplanetary space, presenting itself ultimately as a corollary of the perfected electro-magnetic theory of light.

The chromosphere and prominences present several problems of interest. One of the most fruitful of them relates to the spectroscopic phenomena at the base of the chromosphere, and especially to the strange differences in the behavior of different spectrum-lines, which, according to terrestrial observations, are due to the same material. Of two lines (of iron, for instance) side by side in the spectrum, one will glow and blaze, while the other will sulk in imperturbable darkness; one will be distorted and shattered, presumably by the swift motion of the iron vapor to which it is due, while the other stands stiff and straight. Evidently there is some deep-lying cause for such differences; and as yet no satisfactory explanation appears to me to have been reached, though much ingenious speculation has been expended upon it. Mr. Lockyer's bold and fertile hypothesis, already alluded to, that at solar and stellar temperatures our elements are decomposed into others more elemental yet, seems to have failed of demonstration thus far, and rather to have lost ground of late; and yet one is almost tempted to say, "It *ought* to be true," and to add that there is more than a possibility that its essential truth will be established some time in the future.

Probably all that can be safely said at present is, that the spectrum of a metallic vapor (iron, for instance, as before) depends not only upon the chemical element concerned, but also upon its physical conditions; so that, at different levels in the solar atmosphere, the spectrum of the iron will differ greatly as regards the relative conspicuousness of different lines; and so it will happen that, whenever any mass of iron vapor is suffering disturbance, those lines only which particularly characterize the spectrum of iron in that special state will be distorted or reversed, while all their sisters will remain serene.

The problem of the solar corona is at present receiving much attention. The most recent investigations respecting it—those of Dr. Huggins and Professor Hastings—tend in directions which appear to be diametrically opposite. Dr. Huggins considers that he has suc-

ceeded in photographing the corona in full sunshine, and so in establishing its objective reality as an immense solar appendage, sub-permanent in form, and rotating with the globe to which it is attached. One may call it "an atmosphere," if the word is not to be too rigidly interpreted. I am bound to say that plates which he has obtained do really show just such appearances as would be produced by such a solar appendage, though they are very faint and ghost-like. I may add further that, from a letter from Dr. Huggins, recently received, I learn that he has been prevented from obtaining any similar plates in England this summer by the atmospheric haze, but that Dr. Woods, who has been provided with a similar apparatus, and sent to the Riffelberg in Switzerland, writes that he has an assured success.

Our American astronomer, on the other hand, at the last eclipse (in the Pacific Ocean), observed certain phenomena which seem to confirm a theory he had formulated some time ago, and to indicate that the lovely apparition is an apparition only, a purely optical effect due to the *diffraction* (not *re*fraction, nor reflection either) of light at the edge of the moon—no more a solar appendage than a rainbow or a mock-sun. There are mathematical considerations connected with the theory which may prove decisive when the paper of its ingenious and able proposer comes to be published in full. In the mean time it must be frankly conceded that the observations made by him are very awkward to explain on any other hypothesis.

Whatever may be the result, the investigation of the status and possible extent of a nebulous envelope around a sun or a star is unquestionably a problem of very great interest and importance. We shall be compelled, I believe, as in the case of comets, to recognize other forces than gravity, heat, and ordinary gaseous elasticity, as concerned in the phenomena. As regards the actual existence of an extensive gaseous envelope around the sun, it may be added that other appearances than those seen at an eclipse seem to demonstrate it beyond question—phenomena such as the original formation of clouds of incandescent hydrogen at high elevations, and the forms and motions of the loftiest prominences.

But, of all solar problems, the one which excites the deepest and most general interest is that relating to the solar heat, its maintenance and its duration. For my own part, I find no fault with the solution proposed by Helmholtz, who accounts for it mainly by the slow contraction of the solar sphere. The only objection of much force is, that it apparently limits the past duration of the solar system to a period not exceeding some twenty millions of years; and many of our geological friends protest against so scanty an allowance. The same theory would give us, perhaps, half as much time for our remaining lifetime; but this is no objection, since there is no reason to deny the final cessation of the sun's activity, and the consequent death of the system. But while this hypothesis seems fairly to meet the re-

quirements of the case, and to be a necessary consequence of the best knowledge we can obtain as to the genesis of our system and the constitution of the sun itself, it must, of course, be conceded that it does not yet admit of any observational verification. No measurements within our power can test it, so far as appears at present.

It may be admitted, too, that much can be said in favor of other theories; such as the one which attributes the solar heat to the impact of meteoric matter, and that other most interesting and ingenious theory of the late Sir William Siemens. As regards the former, however, I see no escape from the conclusion, that if it were exclusively true, the earth ought to be receiving, as was pointed out by the late Professor Peirce, as much heat from meteors as from the sun. This would require the fall of a quantity of meteoric matter—more than sixty million times as much as the best estimates make our present supply, and such as could not escape the most casual observation, since it would amount to more than a hundred and fifty * tons a day on every square mile.

As regards the theory of Siemens, the matter has been, of late, so thoroughly discussed that we probably need spend no time upon it here. To say nothing as to the difficulties connected with the establishment of such a far-reaching vortex as it demands, nor of the fact that the temperature of the sun's surface appears to be above that of the dissociation-point of carbon compounds, and hence above the highest heat of their combustion, it seems certainly demonstrated that matter of the necessary density could not exist in interplanetary space without seriously affecting the planetary motions by its gravitating action as well as by its direct resistance; nor could the stellar radiations reach us, as they do, through a medium capable of taking up and utilizing the rays of the sun in the way this theory supposes.

And yet I imagine that there is a very general sympathy with the feeling that led to the proposal of the theory—an uncomfortable dissatisfaction with received theories, because they admit that the greater part of the sun's radiant energy is, speaking from a scientific point of view, simply wasted. Nothing like a millionth part of the sky, as seen from the sun, is occupied, so far as we can make out, by objects upon which its rays can fall: the rest is vacancy. If the sun sends out rays in all directions alike, not one of them in a million finds a target, or accomplishes any useful work, unless there is in space some medium to

* In an article on astronomical collisions, published in the "North American Review" about a year ago, I wrongly stated the amount at fifty tons. There was some fatality connected with my calculations for that article. I gave the amount of heat due to the five hundred tons of meteoric matter, which is supposed to fall daily on the earth with an average velocity of fifteen miles per second, as fifty-three calories annually per square metre—a quantity two thousand times too great. Probably the error would have been noticed if even the number given had not been so small, compared with the solar heat, as fully to justify my argument, which is only strengthened by the correction. I owe the correction to Professor Le Conte, of California, who called my attention to the errors.

utilize the rays, or unknown worlds of which we have no cognizance, beyond the stars.

Now, for my own part, I am very little troubled by accusations of wastefulness against Nature, or by demands for theories which will show what the human mind can recognize as "use" for all energy expended. Where I can perceive such use, I recognize it with reverence and gratitude, I hope; but the failure to recognize it in other cases creates in my mind no presumption against the wisdom of Nature, or against the correctness of an hypothesis otherwise satisfactory. It merely suggests human limitations and ignorance. How can one without sight understand what a telescope is good for?

At the same time perhaps we assume with a little too much confidence that, in free space, radiation does take place equally in all directions. Of course, if the received views as to the nature and conduct of the hypothetical "ether" are correct, there is no possibility of questioning the assumption; but, as Sir John Herschel and others have pointed out, the properties which must be ascribed to this "ether," to fit it for its various functions, are so surprising and almost inconceivable that one may be pardoned for some reserve in accepting it as a finality. At any rate, as a fact, the question is continually started (the idea has been brought out repeatedly, in some cases by men of recognized scientific and philosophic attainment), whether the constitution of things may not be such that radiation and transfer of energy can take place only between ponderable masses; and that, too, without the expenditure of energy upon the transmitting agent (if such exist) along the line of transmission, even *in transitu*. If this were the case, then the sun would send out its energy only to planets and meteors and sister-stars, wasting none in empty space; and so its loss of heat would be enormously diminished, and the time-scale of the life of the planetary system would be correspondingly extended. So far as I know, no one has ever yet been able to indicate any kind of medium or mechanism by which vibrations, such as we know to constitute the radiant energy of light and heat, can be transmitted at all from sun to planet under such restrictions; and it is very difficult to see how any such limited transmission, confined to the lines of gravitational force, could be reconciled with the law of inverse squares. That this law of radiation actually holds in interplanetary space is of course demonstrated by the fact that the calculated brightness of a planet at different places in its orbit and varying distances from the earth agrees with the results of photometric observation. Still, one ought not to be too positive in assertions as to the real condition and occupancy of so-called vacant space. The "ether" is a good working hypothesis, but hardly more as yet.

I need not add that a most interesting and as yet inaccessible problem, connected with the preceding, is that of the mechanism of gravitation, and, indeed, of all forces that seem to act at a distance:

as for that matter, in the last analysis, *all* forces do. If there really be an "ether," then it would seem that somehow all attractions and repulsions of ponderable matter must be due to its action. Challis's investigations and conclusions as to the effect of hydrodynamic actions in such a medium do not seem to have commanded general acceptance; and the field still lies open for one who will show how gravitation and other forces can be correlated with each other through the ether.

Meteors and the comets, seeming to belong neither to the solar system nor to the stellar universe, present a crowd of problems as difficult as they are interesting. Much has undoubtedly been gained during the last few decades, but in some respects that which has been learned has only deepened the mystery. The problem of the origin of comets has been supposed to be solved to a certain extent by the researches of Schiaparelli, Heis, Professor Newton, and others, who consider them to be strangers coming in from outer space, sometimes "captured" by planets, and forced into elliptic orbits, so as to become periodic in their motion. Certainly this theory has strong supports and great authority, and probably it meets the conditions better than any other yet proposed. But the objections are really great, if not insuperable—the fact that we have so few, if any, comets moving in hyperbolic orbits, as comets *met* by the sun would be expected to move; that there seems to be so little relation between the direction of the major axes of cometary orbits and the direction of the solar motion in space; and especially the fact, pointed out and insisted upon by Mr. Proctor in a recent article, that the alteration of a comet's natural parabolic orbit to the observed elliptic one, by planetary action, implies a reduction of the comet's velocity greater than can be reasonably explained. If, for instance, Brorsen's comet (which has a mean distance from the sun a little more than three times that of the earth) was really once a parabolic comet, and was diverted into its present path by the attraction of Jupiter, as generally admitted, it must have had its velocity reduced from about eleven miles a second to five. Now, it is very difficult, if not out of the question, to imagine any possible configuration of the two bodies and their orbits which could result in so great a change. While I am by no means prepared to indorse as conclusive all the reasoning in the article referred to, and should be very far from ready to accept the author's alternative theory (that the periodic comets have been ejected from the planets, and so are not their captives, but their children), I still feel that the difficulty urged against the received theory is very real, and not to be evaded, though it may possibly be overcome by future research.

Still more problematical is the constitution of these strange objects of such enormous volume and inconceivable tenuity, self-luminous and transparent, yet reflecting light, the seat of forces and phenomena unparalleled in all our other experience. Hardly a topic relating to their appearance and behavior can be named which does not contain

an unsolved problem. The varying intensity, polarization, and spectroscopic character of their light; the configurations of the nucleus and its surrounding nebulosity; and especially the phenomena of jets, envelopes, and tail—all demand careful observation and thorough discussion. I think it may be regarded as certain that the explanation of these phenomena when finally reached, if that time ever comes, will carry with it, and be based upon, an enormous increase in our knowledge as to the condition, contents, and temperature of interplanetary space, and the behavior of matter when reduced to lowest terms of density and temperature.

Time forbids any adequate discussion of the numerous problems of stellar astronomy. One work, in its very nature incessant and interminable, consists, of course, in the continual observation and cataloguing of the places of the stars, with ever-increasing precision. These star-places form the scaffold and framework of all other astronomical investigations involving the motions of the heavenly bodies: they are the reference-points and bench-marks of the universe. Ultimately, too, the comparison of catalogues of different dates will reveal the paths and motions of all the members of the starry host, and bring out the great orbit of the sun and his attendant planets. Meanwhile, micrometric observations are in order, upon the individual stars in different clusters, to ascertain the motions which occur in such a case; and the mathematician is called upon again to solve the problem of such movement.

Now, too, since the recent work of Gill and Elkin in South Africa, and of Struve, Hall, and others elsewhere, upon stellar parallax, new hopes arise that we may soon come to some wider knowledge of the subject; that, instead of a dozen or so parallaxes of doubtful precision, we may get a hundred or more relating to stars of widely different brightness and motion, and so be enabled to reach some trustworthy generalizations as to the constitution and dimensions of the stellar universe, and the actual rates of stellar and solar motion in space.

Most interesting, also, are the studies now so vigorously prosecuted by Professor Pickering in this country, and many others elsewhere, upon the brightness of the stars, and the continual variations in this brightness. Since 1875 stellar photometry has become almost a new science.

Then there are more than a myriad of double and multiple stars to watch, and their orbits to be determined; and the nebulæ claim keen attention, since some of them appear to be changing in form and brightness, and are likely to reveal to us some wonderful secrets in the embryology of worlds. Each star also presents a subject for spectroscopic study; for although, for the most part, the stars may be grouped into a very few classes from the spectroscopic point of view, yet, in detail, the spectra of objects belonging to the same group differ considerably and significantly, almost as much as human faces do.

For such investigations new instruments are needed, of unexampled powers and accuracy, some for angular measurements, some for mere power of seeing. Photography comes continually more and more to the front; and the idea sometimes suggests itself that by-and-by the human eye will hardly be trusted any longer for observations of precision, but will be superseded by an honest, unprejudiced, and unimaginative plate and camera. The time is not yet, however, most certainly. Indeed, it can never come at all, as relates to certain observations; since the human eye and mind together integrate, so to speak, the impressions of many separate and selected moments into one general view, while the camera can only give a brutal copy of an unselected state of things, with all its atmospheric and other imperfections.

New methods are also needed, I think (they are unquestionably possible), for freeing time-observations from the errors of personal equation; and increased precision is demanded, and is being progressively attained, in the prevention, or elimination, of instrumental errors, due to differences of temperature, to mechanical strains, and to inaccuracies of construction. Astronomers are now coming to the investigation of quantities so minute that they would be completely masked by errors of observation that formerly were usual and tolerable. The science has reached a stage where, as was indicated at the beginning of this address, it has to confront and deal with the possible unsteadiness of the earth's rotation, and the instability of its axis. The astronomer has now to reverse the old maxim of the courts: for him, and most emphatically at present, *de minimis curat lex.* Residuals and minute discrepancies are the seeds of future knowledge, and the very foundations of new laws.

And now, in closing this hurried and inadequate, but I fear rather tedious, review of the chief problems that are at present occupying the astronomer, what answer can we give to him who insists, *Cui bono?* and requires a reason for the enthusiasm that makes the votaries of our science so ardent and tireless in its pursuit? Evidently very few of the questions which have been presented have much to do directly with the material welfare of the human race. It may possibly turn out, perhaps, that the investigation of the solar radiation, and the behavior of sun-spots, may lead to some better understanding of terrestrial meteorology, and so aid agricultural operations and navigation. I do not say it will be so—in fact, I hardly expect it—but I am not sure it will not. Possibly, too, some few other astronomical investigations may facilitate the determination of latitudes and longitudes, and so help exploration and commerce; but, with a few exceptions, it must be admitted that modern astronomical investigations have not the slightest immediate commercial value.

Now, I am not one of those who despise a scientific truth or principle because it admits of an available application to the affairs of what

is called "practical life," and so is worth something to the community in dollars and cents: its commercial value is—just what it is—to be accepted gratefully. Indirectly, however, almost all scientific truth has real commercial value, because "knowledge is power," and because (I quote it not irreverently) "the truth shall make you free"—any truth, and to some extent; that is to say, the intelligent and intellectually cultivated will generally obtain a more comfortable livelihood, and do it more easily, than the stupid and the ignorant. Intelligence and brains are most powerful allies of strength and hands in the struggle for existence; and so, on purely economical grounds, all kinds of science are worthy of cultivation.

But I should be ashamed to rest on this lower ground: the highest value of scientific truth is not economic, but different and more noble; and, to a certain and great degree, its truest worth is more as an object of pursuit than of possession. The "practical life"—the eating and the drinking, the clothing and the sheltering—comes *first*, of course, and is the necessary foundation of anything higher; but it is not the whole or the most or the best of life. Apart from all spiritual and religious considerations, which lie one side of our relations in this Association, there can be no need, before this audience, to plead the higher rank of the intellectual, æsthetic, and moral life above the material, or to argue that the pabulum of the mind is worth as much as food for the body. Now, I safely assert that, in the investigation and discovery of the secrets and mysteries of the heavens, the human intellect finds most invigorating exercise, and most nourishing and growth-making aliment. No other scientific facts and conceptions are more effective in producing a modest, sober, truthful, and ennobling estimate of man's just place in nature, both of his puny insignificance, regarded as a physical object, and his towering spirit, in some sense comprehending the universe itself, and so akin to the divine. A nation or an individual oppressed by poverty, and near to starving, needs first, most certainly, the trades and occupations which will provide food and clothing. When bodily comfort has been achieved, then higher needs and wants appear; and then science, for truth's own sake, comes to be loved and honored along with poetry and art, leading into a larger, higher, and nobler life.

DROWNING THE TORRENT IN VEGETATION.

By S. W. POWELL.

THE extraordinarily disastrous floods of 1883–'84, in the Ohio River, have again called public attention to the close relation which the wooded or unwooded condition of steep hill-sides, in the areas drained by streams, bears to the volume of water flowing in them.

The State of New York, in particular, is discussing the question of making a great forest reservation in the Adirondacks, in order to avert floods, droughts, and other calamities which there is reason to fear may follow the alleged rapid destruction of the forests of that region.

In the course of this discussion many allusions have been made to the ravages of floods in the south of France, and to the success of efforts to tame those torrents, by reforesting the basins which they drained. A short account of those torrents and their origin, the ruin wrought by them, and the victory which forest science has gained over them, may interest the readers of "The Popular Science Monthly."

Professor Guyot, whose recent death is such a great loss to science, taught that variety of coast-outline, of elevation, of climate, and natural products, is necessary for the richest development of the individual and of society; and that in no part of the world were so many of these favoring conditions originally brought together as in the regions bordering the Mediterranean.

The Roman Empire, which, at the time when it was most widely extended, consisted almost entirely of the countries lying around or near this sea, had the best situation of any of the great empires that have arisen. The grouping and arrangement of the land and water masses; the diversity of elevation and of coast-outline; the rich and varied scenery; the wide range of animal, vegetable, and mineral products; the great number of populous, wealthy, and nobly built cities, with the marvelous Roman roads binding them together, and the majestic Roman law co-ordinating their civic life—all co-operated to make this region the garden of the world. The fact that the most favored part of the earth's surface should have been so nearly ruined, as it has been, by selfish and short-sighted treatment of the forest, its most precious possession, ought to have been a lesson to all future settlers of new territory. That it has not been heeded by the settlers of North America, the increasing frequency and severity of floods and droughts and the swift and menacing approach of timber-famine plainly prove.

The streams which flow through the valleys that wind back from the sea into the heart of the mountains and hills bordering the Mediterranean would, in their normal condition, be limpid and perennial. But, owing to this short-sighted cutting of timber from steep hillsides, and to the equally short-sighted over-pasturing of the cleared spaces afterward with sheep and goats, most of these streams were, in the upper part of their courses, changed into torrents, whose beds in dry weather are cheerless expanses of sand and gravel.

During heavy rain, or when snow is rapidly melted upon the mountains (and this is especially apt to occur when a warm wind, called the *Fœhn*, coming probably from Sahara, and saturating itself with

moisture as it crosses the Mediterranean, strikes the mountains—Guyot said he had known this wind to melt six feet of snow in twenty-four hours), these torrent-channels are almost instantly filled with furious, short-lived floods, which often sweep off bridges, buildings, crops, and even animals and human beings, besides tearing up costly roads, and wash away a vast amount of precious soil from mountain-sides, where it is sorely needed, and deposit it in rivers and harbors, where it is a nuisance, and often a serious peril to navigation.

In their gullying and undermining rage, these torrents tear out stones and large rocks from the hill-sides, grind them up into gravel, and even fine sand, and ruin much fertile land upon which they spread this material.

Marsh, in his "Earth as modified by Human Action" (p. 272), gives Surell* as his authority for the statement that "the fury of the waters, and of the wind which accompanies them in the floods of the French Alpine torrents, is such that large blocks of stone are hurled out of the bed of the stream to the height of twelve or thirteen feet"; and remarks that "the impulse of masses driven with such force overthrows the most solid masonry, and their concussion can not fail to be accompanied by the crushing of the rocks themselves." On page 273, note, he quotes Coaz ("Die Hochwasser im 1868," p. 54) : "At Rinkenberg, on the right bank of the Vorder Rhein, in the flood of 1868, a block of stone, computed to weigh nearly nine thousand cwt., was carried bodily forwards, not rolled, by a torrent, a distance of three quarters of a mile."

But there is further mischief, which, as being more widely diffused, is less sure to be assigned to the true cause—the stripping steep land of its covering of trees :

1. There is the failure of springs, because water of precipitation, which should have been delayed upon the hill-sides by the roots, sprouts, mosses, fallen leaves, etc., which fill and cover the surface of the ground under a forest, till it could find the underground spring-sources, runs off the bare slopes in a few hours. Dry springs mean parched pastures, small crops, and unprofitable husbandry.

2. The increased cost of buildings, bridges, furniture, and implements of all sorts, which are, in whole or in part, made of wood. A large item in the current expenses of railroads is the outlay for ties, which must be renewed frequently. Wood for fuel or structural uses is a prime necessity of civilized life ; and, as it is bulky, its cost increases rapidly with the distance it must be carried to reach the consumer. Many countries have no stores of coal or peat, and must have wood, or be sorely stinted for fuel ; that stinting is a waste of time, health, and vitality. Floods make the maintenance of roads difficult and costly, and so, of course, increase the expense of whatever

* "*Étude sur les Torrents des Hautes Alpes*," published in 1841. This and the supplementary volume by Cézanne (1870) are of the first importance.

must be hauled over them, especially anything so bulky as wood.* Further, scarcity of timber means the cessation of many lucrative industries which use wood for their raw material, and which are especially desirable as affording employment during portions of the year, when agriculture or the care of flocks does not call for all of the farmer's time.

3. There is the derangement of climate and rainfall. It is by no means certain that, at least, in some situations, more rain will not fall in a year upon a well-wooded than upon a bare region. Certainly, what does fall will not evaporate, and be carried away by the winds as quickly. Sudden changes of temperature, and the resulting violent winds are also less liable to occur where woods abound. A forest is a better barrier against wind than a stone wall of equal height, because it divides its force, and does not stop it all at once, causing eddies and rebounds which may do damage elsewhere.

In these and other ways many provinces of Southern France had been (before 1860) for several generations gradually growing poorer. By a misuse of the right of equal common pasturage upon the lands belonging to the communes, the richer proprietors who had large flocks could get the lion's share of the scanty store. To lighten taxes, sheep and goats were admitted from Provence and the Maritime Alps to summer pasturage, as at that season their own country was so dry and parched that they could find no food. Cézanne, in his supplement to the great work of Surell on the "Torrents of the High Alps," says these migratory flocks "obstruct the roads, and are the occasion of all kinds of disorder. They arrive at the pastures famished, and in a few days destroy the sprouting herb, the hope of the entire season. . . . One can follow the trail of the sheep of Provence by the disappearance of all vegetation. They necessarily migrate in flocks of one thousand or twelve hundred, and after reaching the pastures retain the habit—which they acquire upon the road—of crowding together and struggling for every spear of grass. In the flinty plains of the south they find very scanty fare, and, to satisfy hunger, are obliged to move stones with their noses and feet, and to dig the soil quite down to the roots of the plants which they devour. Upon the mountains they continue the same destructive habits, and one can understand what must be the effect upon the light soil, scarcely fixed upon the slopes, of such digging and tearing by these millions of animals" (pp. 245, 246).

The little ready money which the pasture-fee of these southern

* Ladoucette, in his "Histoire, Topographie, Antiquités, Usages, Dialectes des Hautes Alpes," says that the peasant of Dévoluy often goes a distance of five hours, over rocks and precipices, for a single man's load of wood; and that the justice of the peace for that cantonment had, in the course of forty-three years, but once heard the voice of the nightingale. Thanks to reforesting, wood and nightingales' songs are there now in abundance.

sheep brought into the impoverished communal treasuries seemed indispensable, though it was easy to see that it was bad economy to admit them. Such trampling and tearing weakened the turf so that it was every year more easily washed down-hill during heavy rain, and, when it went, the soil underneath went too. The farther down the mud and water rushed, the deeper and wider were the erosions. Upon the steeper slopes below, which should have been clothed with woods, the ravages were still greater. As like causes were operating in a similar way upon other surfaces in the same basin, after every heavy rain (especially if it fell upon deep snow) the streams suddenly rose thirty, forty, and even sixty feet, and then again, in a few hours, were at their old level.

If a bank overhanging the narrow gorge at the mouth of one of these mountain-basins was undermined and fell across the opening, a lake quickly formed behind, until the accumulating pressure burst the barrier, and then woe to the people down-stream! In one such *débâcle* the wave was one hundred feet high, and swept down the valley at the rate of fifty feet a second, or thirty-four and one eleventh miles an hour! "At one point the water was seen pushing before it a moving mountain of all kinds of *débris* of three hundred feet in height, from which was rising a thick cloud like the smoke of a conflagration" (Brown's "Reboisement in France," pp. 86–89).

Deprived by their own improvidence, or that of their parents, of their forest wealth, the mountaineers thought that they must starve, or else use every available acre for pasturage. Planting trees and waiting for them to grow required knowledge and capital, and they had little of either. The damage done by torrents was more severe farther down, although it all began in the uplands, whose turf was loosened by the starved sheep of the south. Lack of the timber which should have enriched and protected the zones just below these pastures made the mountaineers feel so poor that they felt constrained to take every sheep and goat which the lowlanders would bring. It was clear that they could not restrict the number of these "summer boarders" and at the same time reforest the steeper lower zones to the extent which was demanded by their own welfare, and still more by that of the people living farther down-stream.

This made it necessary for the state to step in. Under the feudal system it was held that a seignior, and especially a king, must possess one or more forests. In France, those belonging to the crown have become the property of the state, and, for the care of these there have gradually been trained a special class of officers. When the reboisement law of 1860 was passed, many of these were men of great attainments. Surell, born in the Département des Hautes-Alpes, was one of the most eminent among them. As an engineer he had long been familiar with the numerous and costly—and yet inadequate—mechanical expedients which had been tried by the authorities for the purpose of

preventing the ravages of torrents. He kept dinning it into their ears that, since excessive and unscientific clearings, and unregulated pasturage of the cleared spaces afterward, were the causes of the torrents, so the remedy must be to clothe the steeper zones below the pastures with trees or bushes, and to exclude sheep and goats from the pastures above until they were again covered with a stable turf.

He was not, indeed, the first to protest against the destruction of the woods, and to insist upon their restoration. The famous inventor, engineer, and artist, Bernard Palissy (born about 1509), had discovered the influence of forests upon springs, and raised an unheeded cry to warn men against the calamities which lack of fuel and timber would occasion. The chief nobles, and especially the ecclesiastics, were clearing at a great rate and taking no thought of those who would come after them. In the time of Henry IV and Louis XIV a sharp check was given to the plundering of the crown forests by these ecclesiastics and court favorites. In 1669, three years after the famous announcement of Louis XIV that he had been long enough in leading-strings, and that he proposed from that time to be master of himself and of France, the great ordinance was passed upon which most of the subsequent forest legislation of Europe has been based. Under it, in connection with the crown forests, the science of arboriculture was studied, and a thoroughly organized corps of officials trained.

Before we come to Surell, a passing mention should be made of Fabre and Dugied. Fabre published in 1797 his "Essai sur la Théorie des Torrents et des Rivières," which may be called a prophetic work. It outlines quite distinctly the main principles which were followed in the works of restoration under the reboisement law of 1860. He said sheep and goats must be kept away from young trees, and that no clearing should be permitted except in horizontal strips not more than thirty feet in width where the acclivity of a slope is more than one foot in three, and these strips may be made wider according as the slopes are less steep. No clearings without authorization of competent officials, and on plans made by them. Where there was little earth left, he recommended *gazonnement** and *buissement*.

Dugied, who had been a prefect in the Lower Alps, published a project for reforesting the Basses-Alpes. He said that more than half that department was dry and unproductive soil, and that torrents caused by cutting and grubbing woodland brought *débris* and added to the barren areas. For remedies he recommended: 1. Enforcement of the old law of 1667, which imposed a fine of three thousand francs for grubbing steep land; land already grubbed to be turned into

* *Reboiser*, to reforest; *deboiser*, to deforest; *gazonner*, to plant with turf; *buissonner*, to plant with bushes, with their nouns, *boisement*, *reboisement*, *deboisement*, *gazonnement*, *buissonnement*, are in constant use in French forest literature. The nouns are, in translations, often transferred to the English, and sometimes one meets, to *reboise* = to *reforest*.

artificial meadows. 2. He made careful estimates of the cost of reforesting the one hundred and fifty thousand hectares in the department which needed it, and recommended that, besides remitting taxes for ten years on reforested land, and distributing seeds gratis, the state should pay three quarters and the department one quarter of the cost. He showed that the increased revenue from taxes, after the ten years of exemption, would repay the advance in eighty-six years.

Almost every one ridiculed the proposal; it was compared to the "Arabian Nights"; and, as a reward for making it, he was deposed. But, at the same time the state was expending one hundred and twenty million francs each year for roads and bridges, and a large part of this outlay—vastly more than reforesting cost when at last wiser counsels prevailed—was made necessary by torrents which every year grew worse, but which reforesting cured.

Dugied's ideas were, in the main, those finally adopted, except that he left out the essential idea of compulsion. An entire torrent-basin must be taken in hand at the same time, and one uniform process be carried on over the whole of it. As Surell said, success should not be imperiled by the first stupid or stubborn peasant who would not do his part. The state must not only bear the expense, but also assume the direction. Expropriation or confiscation must be resorted to, as is done in taking land for roads, etc.

In May, 1856, when heavy rains fell all over France, floods in the valleys of the Loire and the Rhone did incalculable damage. This so re-enforced the appeals which had been made by specialists like Fabre, Dugied, and Surell, that the Corps Législatif consented to make a trial of the new way of fighting floods. The old way—erecting barriers, etc.—had been altogether defensive; the new was almost wholly offensive. The method, as an expert expressed it, was "*to drown the torrent in vegetation*"—that is, to turf the higher and more level pastures, and then to retard the flow of water down the steeper slopes below the pastures by trees, bushes, fallen leaves, and mosses, so that much of it would have time to soak into the ground and reach the spring-reservoirs, and another large portion be absorbed by the fallen leaves, etc., and held as by a sponge, or be taken up by the growing vegetation; and to hold back the remainder by millions of small obstacles so that it would reach the stream no faster than a full channel could carry it away; and, finally, that, flowing at no point over bare soil, it might reach the stream-bed as limpid as when it started down-hill.

Difficulties.—The hindrances to the success of the work were both moral and physical, but the moral were the greater. They were: 1. The unwillingness of an ignorant peasantry to try any new thing; 2. Reluctance on the part of the Corps Législatif and of local authorities to interfere with private rights as much as the success of the work

demanded; and, 3. The doubt whether such torrents would not wash away the plantations as fast as they could be made.

The first two difficulties demanded great patience and kindness in making clear to the peasants the necessities and advantages of reforesting, and in convincing them that the work would be done so honestly and cheaply that they might reasonably expect to be able to repay the cost of the work and get back their land, which would soon begin to yield some income, and in the course of twenty years would, as a rule, be more profitable than pasture-land. A sort of science primer, "Les Études de Maître Pierre sur l'Agriculture et les Forêts," was prepared and circulated among them with excellent results. It consists of eight dialogues between a government teacher and a peasant, Maître Pierre, in which the latter is converted from a stubborn opposition to the reboisement law (which he said would ruin him because, in obedience to it, his landlord was about to withdraw a certain pasture from his *moutons*) to a quite intelligent advocacy of it. The main reasons for and methods of forest propagation, conservation, cutting, thinning, etc., are gradually instilled into the peasant's not very bright mind. The book is a fine model of Socratic teaching.

The velvet glove was always kept upon the iron hand in carrying out the law. As far as possible the co-operation of those whose land was taken was secured; and none was taken except after full opportunity for every one to learn just what the government meant to do and to present objections. Local magistrates and land-owners must be united with the state officials upon the boards which decided where to run the lines which included lands to be reforested.

The third difficulty—doubt as to the possibility of success—was overcome by the prudently bold policy of attacking some of the worst torrents first. Of course, victory over these insured success with less violent ones.

The conflicts with physical obstacles may be classified as preparatory and final. The first thing was to exclude sheep and goats from the pastures above the forest zone. The next was to divide the whole area by horizontal walls into two or more zones, and in the lateral ravines to build as many dams as the case might require, so as to check the downward flow of water and compel deposit of earth above the walls and dams. In the deeper ravines whole trees were thrown with tops down-hill, fascines, etc., being packed among the limbs. Then, with explosives, the sides of the ravines were thrown down upon these trees so as to afford a deep and somewhat level soil that could be planted at once. Horizontal mule-paths about a metre wide were made where, later on, roads for working the forest would be needed. These paths, in passing ravines, ran upon the dams, etc., and by them laborer and material could reach the points where they were needed in the preliminary works. Besides these paths there were made, at distances twelve

or fourteen feet apart, narrow terraces, supported on their lower edges by pebble walls, and having their upper surfaces slightly sloping in toward the mountain, so that water would be checked, and, as far as possible, made to soak in and find the spring-reservoirs.

After all these preliminary works were executed, the final planting began. Generally, the terraces and the more level and deep made-ground in the lateral ravines were stocked from nurseries which were established here and there in the districts to be reclaimed. Where the spaces between the terraces were especially liable to washing, they were covered by thatchings of brush, retained if necessary by stones or any convenient rubbish.

In gorges and other places where the danger of erosion and the difficulty of getting out large timber would be greater than elsewhere, the kinds of trees selected were such as shoot readily from the stump, grow rapidly, and can be frequently cut with profit—in other words, those more especially suited to coppice or sprout-growth culture. A dense coppice resists the pelting of rain and fixes the soil better than larger trees. The kinds selected for such places were therefore acacias, ashes, elms, maples, willows, alders, poplars, lindens, etc.

By working with a sufficiently large force to cover an entire basin with the various preliminary works, and then to plant, promptly and simultaneously, the plantations were not washed away; on the contrary, to use the vivid words of Cézanne: "These works, so ingenious in their very simplicity, form a net-work of horizontal lines, like the alleys of a garden. The green edgings and linings develop themselves among the innumerable sinuosities of the *combes* [valleys], embracing, from the rocky beds of the torrents to the very summit of the mountain-crests, those ravines which were but lately inaccessible, and presented an aspect full of horror. On seeing what has been done, one immediately understands how such a combination should be effectual. Every liquid molecule, so to speak, is seized individually, the thin sheet of water flowing down is retarded in its course by a thousand thirsty little plants, by the lines of cultivated herbage, and by the hedges of shoots and trees. It is compelled to tarry a little on each terrace to slake the thirst of the ground, and when it reaches the lower end of a furrow it spreads itself out on the flattened bed there prepared for it. Stopped at every barrier, it loses its vital force on every hand, and finally, from resting-place to resting-place, and from descent to descent, it arrives, after a thousand retardations, and still limpid, in the channel which conveys it to the river. The violence of torrents is occasioned by the combination of an infinitude of elements infinitely minute; and the system of extinction consists in extinguishing each of these elements without disregarding one; it is an accumulation of infinitesimal littles. The secondary ravines are blocked up, their minute ramifications are intercepted, the lesser flanks are filled up, and finally there are spread over the soils, completely to diffuse them,

the innumerable threadlets [of water], divided and subdivided like the fibers of a root."

In conclusion, it is gratifying to be able to state that all opposition to the reboisement law is in France a thing of the past. The credits voted for the first ten years were at the rate of only two hundred thousand francs a year. Now nearly twenty times as much is readily obtained by the forest administration. The total annual outlay upon the state forests is about twelve million francs, but the direct revenue derived from them is more than three times that sum, besides the vastly greater incidental advantage of building up the agriculture, commerce, manufactures, health, and general prosperity of the restored regions, to say nothing of the diminished expenditure needed to replace roads, bridges, and other structures formerly destroyed by the torrents. How much longer shall we refuse to heed what the experience of other countries teaches with regard to the treatment of forests?

In the recent Ohio floods the States which suffered most—Ohio, Indiana, and Illinois—were not those where most of the deforesting was done which caused the floods. The Hudson's head-waters are almost all in New York, and it is in the power of her Legislature to provide the needed safeguards.

WHAT IS ELECTRICITY?*

By JOHN TROWBRIDGE,

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THE conjunction of the meeting of the American Association with the opening of the Electrical Exposition and the sittings of the National Electrical Congress leads me to say a few words upon a question which we all ask ourselves, and to which we have hitherto had no response: "What is electricity?"

After I have concluded, you will probably still ask yourselves, "What is electricity?" All I can hope to do is to make you ask yourselves the question with more humility, and a greater consciousness of ignorance; for the ignorant man, I have found, is generally sure that he knows what electricity is; and, the more learned a person is, the more he is convinced that he does not know what electricity is.

There is an advantage in sounding the depths of our ignorance, and in surveying, even from a small Mount Pisgah, the paths we have traversed, and the great promised land which lies before us. In the beginning I must express my conviction that we shall never know

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what electricity is, any more than we shall know what energy is. What we shall be able probably to discover is, the relationship between electricity, magnetism, light, heat, gravitation, and the attracting force which manifests itself in chemical changes. We have one great guiding principle which, like the pillar of cloud by day, and the pillar of fire by night, will conduct us, as Moses and the Israelites were once conducted, to an eminence from which we can survey the promised scientific future. That principle is the conservation of energy. To-day we see clearly that there are not different kinds of forces; that light is not one thing and heat another; that, in truth, we should blot the word light from our physical text-books; that electricity and magnetism have their equivalents in heat, and heat in mechanical work. The ancients had a god for every great manifestation of Nature—a god of peace, a god of war, a god of the land, a god of the sea. Fifty years ago scientific men were like the ancients. There was a force attached to every phenomenon of Nature. Thus, there were the forces of electricity and magnetism, the vital forces, and the chemical forces. Now we accept treatises on mechanics which have the one word "Dynamik" for a title; and we look for a treatise on physics, which shall be entitled "Mechanical Philosophy," in which all the phenomena of radiant energy, together with the phenomena of energy, which we entitle electricity and magnetism, shall be discussed from the point of view of mechanics. It is true that Mascart and Joubert have entitled their treatise on electricity and magnetism "The Mechanical Theory of Electricity and Magnetism"; but what we are to have in the future is a treatise which will show the mechanical relations of gravitation, of so-called chemical attracting force and electrical attracting force, and the manifestations of what we call radiant energy.

When we survey the field of modern physics, we see that there is a marked tendency to simplify our conceptions. The question is sometimes asked, How shall the man of the future be able to make any advance, since it now takes one until middle age to gain familiarity with the vortex theories, with quaternions, and the more or less complicated mathematical analysis which characterizes our mechanical theory of electricity to-day? It is evident that much of our complicated scaffolding is to be taken down, and the student of electricity in the future will start with, perhaps, the laws of vortices as axioms, just as the student in physics to-day starts with the truth that the energy which we receive from the sun does not exist either as light or heat in the space between us and the sun, but may be electro-magnetic, or even in an unsuspected form; and that light and heat are merely manifestations of waves of energy differing only in length.

We have reduced our knowledge of electricity and magnetism to what may be called a mechanical system, so that, in a large number

of cases, we can calculate beforehand what will take place, and we are under no necessity of trying actual experiments.

Thus, a portion of our knowledge of electro-magnetism is very much in the condition of our knowledge of what may be called geometrical astronomy, in distinction to physical astronomy. We can calculate what will take place with small errors, which arise merely from the faults of observation, and not from a want of knowledge of conditions, or from the errors of a defective theory. It is probable, for instance, that the correct form of a dynamo-machine for producing the electric light can be calculated, and the plans drawn with as much certainty as the diagrams of a steam-engine are constructed. There is a department of electricity corresponding, perhaps, to hydraulics, in which the electrical engineer can find full employment in subjecting perfectly definite conditions to exact calculation. We can congratulate ourselves, therefore, in having a large amount of systematic knowledge in electricity, and we see clearly how to increase this systematic knowledge; for we have discovered that a man, to become an electrician, can not expect to master the subject of electricity, who has not made himself familiar with thermo-dynamics, with analytical mechanics, and with all the topics now embraced under the comprehensive title of physics.

Some may think that an electrician is a narrow specialist. I can only invite such persons to engage in the study of "What is electricity?"

In standing upon our scientific Mount Pisgah, we can survey the beaten roads by which we have advanced, and can see partially what has been good and what has been bad in the theories which have stood in the place of the leaders of the Israelites and have conducted us thus far. Out of all the theories—the two-fluid theory, the one-fluid, or Franklin theory, and the various molecular theories—not one remains to-day under the guidance of which we are ready to march onward. The two-fluid theory serves merely to fix the ideas of the student whose mind is new to the subject of electricity. I think I can safely affirm that no scientific man of the present believes that there is even one electric fluid, to say nothing of the existence of two. We have discovered that we can not speak of the velocity of electricity. We do not know whether the rate of propagation of what we call an electrical impulse is infinitely slow or infinitely fast. We do not know whether what we call the electrical current in a conductor is due to molecular motions infinitely faster than those of outlying molecules, or whether there is a sudden comparative cessation of molecular motion in the wire through which the current manifests itself, compared with the molecular motions outside the wire, for this might produce the electrical phenomena we observe. We do not know whether any molecular motion is concerned in the manifestation of energy which we call electrical. All that we can truly say is, we have

a healthy distrust of our theories, and an abiding faith in that pillar of cloud by day and the pillar of fire by night—the doctrine of the conservation of energy.

Having thus outlined the present condition of our knowledge, and of our comprehension of the bearing and tendencies of physical science, let us strive, with the most powerful instruments we have, to survey the promised land which is undoubtedly to be the possession of those who come after us. It is one thing to become familiar with all the applications of the mechanical theory of electricity, and another to make an advance in the subject so that we can see the relations of electrical and magnetic attraction to the attraction of gravitation and to what we call chemical attraction. To this possible relationship I wish to call your attention to-day.

I am forced to believe that the new advances in our knowledge of electrical manifestations are to come from a true conception of the universality of electrical manifestations, and from the advance in the study of molecular physics. Picture to yourselves the position of an investigator in this world. A person on the moon could only conceive of this audience as a molecule made up of many atoms. He could not measure the energy you manifest by moving about—the heat energy—the electrical energy due to the friction of your envelopes. Indeed, he could only suppose your existence, just as we imagine the existence of a molecule of a crystal. Now, the distances we force molecules apart by many of our chemical processes seem extremely small to us; but how immense they really are compared with the distances apart of the atoms! Is it not as if we should take a stone from the moon or from Venus and place it upon the earth in the time of one second? You can imagine, from the familiar spectacle of a meteor, the heat and the electricity that would result. Yet, in respect to relative distances, do we not do something similar when we break a crystal or pour acid upon a metal, or strike a dynamite-cartridge? We are infinitely small ourselves compared with the great universe about us; yet our task is to comprehend the motions of aggregations of atoms infinitely smaller than that aggregation which we call man.

When we break a crystal mechanically, we have a development of electricity. When we heat certain crystals—tourmaline, for example—besides the strain among the molecules of the crystal which is produced by the increased rates of vibration, we have a difference of electrical potential. When we let an acid fall from the surface of a metal, the metal takes one state of electrification and the drop of acid the other—in other words, we produce a difference of electrical potential. On the other hand, a difference of electrical potential modifies the aggregation of molecules. The experiments of Lippman are well known to you. He has constructed an electrometer, and even an electrical machine, which depend upon the principle that the superficial energy of a surface of mercury covered with acidulated water is modified

when a difference of electrical potential is produced at the limiting surfaces. I have lately noticed a striking illustration of the modification of superficial energy by a difference of electrical potential. The experiment can be performed in this way: Fill the lower part of a glass jar with clean mercury, pour a saturated solution of common salt upon the mercury, hang in the salt solution a carbon plate, and connect this plate with a battery of four or five Bunsen cells; and, on connecting an iron wire with the other pole of the battery, touch the surface of the mercury. An amalgam will be speedily formed and chlorine gas given off. After a slight film of this amalgam has been formed on the mercury, remove the iron wire, and then immerse it slowly in salt-and-water. Even at a distance of six inches from the mercury, and far below the carbon electrode, the surface of mercury will be disturbed by the difference of electrical potential, and a commotion, which might be called an electrical storm, will be observed upon its surface. Now, these manifestations of what is called superficial energy—that is, the energy manifested at the surface of separation of any two media, and the effect of electricity upon this superficial energy—afford, it seems to me, much food for thought. There have always been two parties in electricity—one which maintains that electricity is due to the contact of dissimilar substances, and the other party which believes that the source of electrical action must be sought in chemical action. Thus, according to one party, the action of an ordinary voltaic cell is due to the contact, for instance, of zinc with copper, the acid or solution of the cell merely acting as the connecting link between the two. According to the other party, it is to the difference of chemical action on the two metals of the connecting liquid that we must attribute the rise and continuance of the electrical current. It has always seemed to me that these two parties are like the knights in the story, who stood facing opposite sides of a shield, each seeing but one side, one protesting that the shield was silver and the other that it was gold, whereas it was both silver and gold.

The electro-motive force of a voltaic cell is undoubtedly due to the intrinsic superficial manifestation of energy. When two dissimilar metals are placed in connection with each other, either directly or through the medium of a conducting liquid, the chemical action of the liquid brings new surfaces of the metals constantly in contact. Moreover, we have the difference of superficial energy between the liquid and the two metals. So that our expression for electro-motive force is far from being a simple one; it contains the sum of the several modifications of superficial energy at the surfaces of the two metals, and at the two boundaries of the liquid and the metals.

Let us turn now to the subject of thermo-electricity. Here we have again a development of electro-motive force by the mere contact of two metals, when the junctions of the metals are at different temperatures. There is no connecting liquid here, but the surface of one

metal rests directly upon that of the other. The electrical current that arises is due to the difference of superficial energy manifested at the surfaces of the two junctions. We know that the action is on the surface, for the dimensions of the junctions do not affect the electro-motive force. Suppose that we should make the metals so thin that an ultimate molecule of iron should rest against an ultimate molecule of copper. Should we not arrive at a limit, at a definite temperature of the conversion of molecular vibration into electrical energy, and, also, when our theory is perfected, of the number of molecules along a linear line of copper against a linear line of zinc which can produce a current of electricity of a given strength? I have often thought that the jostling, so to speak, of these ultimate molecules of two metals at definite temperatures might form a scientific unit of electro-motive force in the future science of physical chemistry. Look at the great field for investigation there is in the measurement of what we call electro-motive force, both in voltaic electricity and in thermo-electricity. The astronomer measures the positions of the stars and their light, and tabulates the enormous volumes of results from year to year, in order to ascertain some great law or laws of the possible changes of the entire stellar universe—some sweeping onward through space. Is it not fully as important that, in our physical laboratories, we should organize our routine work, and provide some great generalizer, like Sir Isaac Newton, with sufficient data of electro-motive force, or, as I prefer to call it, the relations of superficial energy, in order that the relations between this energy and the ultimate motions of the molecular worlds may become better known to us?

When the world was evolved from the first nebulous stage, a portion of the atoms remained more or less free in the gaseous state, another portion became more or less limited in organic forms, and another portion were tightly compressed into solids more or less elastic. This elasticity is thought by some to be an evidence of very rapid motion through all these various aggregations of matter—or shall we say different manifestations of motion? for some also believe that our ideas of matter result merely from a perception of motion. Shall we affirm that there is some relation between elasticity and electricity? I do not think that we are prepared to do so, for some elastic bodies are good conductors and some are poor conductors of electricity. We can see dimly, however, that there is a great field in molecular physics, in which elasticity and superficial energy and difference of electrical potential shall be treated together.

I have tried various experiments upon the electro-motive force of alloys. By means of an alloy we can apparently modify the superficial energy at the surface of a solid. Thus, an alloy with a parent metal will give a varying electro-motive force. If we could be sure that an alloy is always a definite chemical composition, and not a more or less mechanical admixture, it seems as if we could get closer

to the seat of electro-motive force by a number of quantitative measurements. Unfortunately, the physical nature of alloys is not definitely known, and there is little coherence or regularity in our measurements of their electro-motive force. Still, there is a great field in the study of the electro-motive force of alloys. We can modify the superficial energy of metals, not only by melting metals together, but also by grinding them to a very fine powder, and compressing them again by powerful means into solids more or less elastic, and then examining their superficial energy, which is manifested as electro-motive force. I am still engaged upon researches of this nature, and, if the work is not brilliant, I hope that it will result in the accumulation of data for future generalization.

We can not treat the manifestation of electro-motive force in the voltaic cell apart from the manifestation of electro-motive force in the differently heated junctions of a thermo-electric junction. In both cases there is a difference of manifestation of superficial energy; and in thermo-electricity we can also modify this energy by making alloys. The subject of thermo-electricity has been eclipsed by the magnificent development of the dynamo-electric machine, but we may return to thermo-electricity as a practical source of electricity. I have been lately occupied in endeavoring to modify the difference of potential of two thermo-electric junctions, by raising one junction to a very high temperature under great pressure; for it is well known that the melting-point of metals is raised by great pressure. If the metal still remains in the solid state under great temperature and great pressure, can we not greatly increase the electro-motive force which results from the difference of superficial energy manifested at the two junctions?

When an electrical current is passed through two thermo-electric junctions, it cools the hot one and heats the cool one. Moreover, you are well acquainted with Thomson's discovery that a current of electricity, in passing through a metal, carries heat, so to speak, with it—in one direction in iron and in another in copper. Do we not see here a connection between the manifestation of superficial energy in liquids and the effect of a difference of potential upon it, and the manifestations of thermo-electro-motive force and the effect of differences of electrical potential? It is curious and suggestive that, in applying the reasoning of Carnot's cycle to the effect of a difference of electrical potential on the superficial energy at the surface of separation of two liquids, one is led to the equations which express in thermo-dynamics the Peltier and Thomson effects.

In thus looking for the seat and origin of electrical action, how much have we discovered? It is evident that our knowledge of electricity will increase with our knowledge of molecular action, and our knowledge of molecular action with that which we call attractive force. It is somewhat strange that, although we are so curious in

regard to electricity, we seldom reflect that gravitation is as great a mystery as electrical attraction. What is this force which acts instantly through space, and which holds our entire solar system together? We know only its simple law—that it attracts bodies directly as their masses and inversely as the square of their distance; but we do not know what relation it bears to electrical force or magnetic force. Here is a field in which we are to push back our boundary of electrical knowledge. I will not call it electrical knowledge, but rather our knowledge of the great doctrine of the conservation of energy. What is the relation between electricity, magnetism, and gravitation, and what we call the chemical force of attraction? It seems to me that this is the question which we must strive to answer; but, when this question is answered, shall we not be as far as ever from the answer to the question, "What is electricity?"

The question of the connection between electricity and gravitation dwelt much in Faraday's thoughts. It is interesting to recall the experiments which he instituted to discover if there is any connection between these great manifestations of force. In his first experiment he suspended vertically an electro-magnet, which was connected with a delicate galvanometer, and let various non-magnetic bodies, such as brass bodies, pieces of stone and crystals, fall through the center of this electro-magnet, thinking that there might possibly be a reaction from the influence of gravitating force on the falling body which would be manifested as an electrical current. He did not, however, obtain the slightest electrical disturbance which might not have been caused by simple electrical induction. He then arranged a somewhat complicated piece of apparatus by means of which a body could be moved alternately with the direction of gravitation and against it, and the terminals of a galvanometer were so connected that the intermittent effects, if they existed, could be integrated or summed up. He failed, however, to find the slightest relation between gravitation and electricity, and he closes his account of his experiments with these words: "Here end my trials for the present. The results are negative. They do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exists."

Since Faraday's time no connection or relation has been found except in the similarity of the law of inverse squares. I have often reflected upon these experiments of Faraday, and have asked myself, Was the direction in which he experimented the true direction to look for a possible relation; and can not the refined instruments and methods of the electrical science of the present aid us in more promising lines of research? Should we not expect that, when two balls of copper, for instance, are suddenly removed from each other, a difference of electrical potential should manifest itself, and that the electrical force thus developed should be opposed to our endeavor to

overcome the attractive force between the masses of copper? Moreover, when we force the copper balls together, should we not expect that an electrical charge should be developed of such a nature as to oppose our motion? And thus in these mutual relations, which are apparently consistent with the doctrine of the conservation of energy, should we not expect to find the relation which we are in search of? Our experiment, therefore, would have to be conducted in this way: We should carefully insulate our two copper masses, estimate the effects that would be due in any way to cutting the magnetic lines of force of the earth, and then with a delicate electrometer, the masses having been placed in a vacuum to get rid of the effect of friction of the air, we should proceed to test their electrical relations. This experiment also gives negative results, but may we not try it under better conditions than I have been able to devise? If we could prove that whenever we disturb the relative position of bodies, or break up the state of aggregation of particles, we create a difference of electrical potential, and, moreover, if we could discover that the work that this electrical potential can perform, together with the heat that is developed by the process, is the complete work that is done on the system against attractive force, whether expressed in gravitation attractive force, or as so-called chemical attractive force, we should greatly extend our vision of the relation of natural phenomena. In thus pursuing the line of argument of my address, I venture to state an hypothetical law which it seems to me is at least plausible in the present state of electrical science, and may serve as a scaffolding to be taken down when experiment shall have properly proportioned the edifice.

This hypothetical law I should state as follows: "Whenever the force of attraction between masses or molecules is modified in any way, a difference of electrical potential results."

In what I may therefore call the physical chemistry of the future, may we not expect that in the reactions we must express the equivalent of the difference of electrical potential in the summation of the entire work which is done? I can make my meaning clearer by referring to an experiment of Hirn by which he obtained a fair value for the mechanical equivalent of heat. In principle it is this: A heavy weight falls upon a lead vessel which contains a given amount of water at a definite temperature. The lead vessel suffers compression by the blow, and the water is raised in temperature. It is found, on properly estimating the amount of heat taken up by the lead and the loss radiated during the experiment, that the heat produced by the blow is the equivalent of its mechanical work. Suppose now that the vessel containing the water should be made of two metals of about the same specific heat or capacity for absorbing heat, and suppose that wires should connect the two different metallic portions with a similar vessel containing water. We should have here two thermo-electric junctions at the same temperature. When the weight falls upon one junction and

heats it with its contained water, we have not only the heated water but also an electrical current; it is evident, therefore, that we should be able to heat the water more when the wire between the two vessels is cut, than when there is a metallic circuit between them, for a part of the energy of the falling weight has become converted into an electrical current. At the terminals of the cut wires there is a difference of electrical potential created for an instant, which, however, instantly disappears. What is the equivalent of the disappearance of this difference of potential? Is it not in the closed circuits through the masses of the metals, a part of which, it is true, becomes sensible heat, but another portion may become latent heat or do internal work among the molecules?

Moreover, is it not reasonable to suppose that certain anomalies which we now find in the determinations of specific heats of complicated aggregation of molecules are due to our failure to estimate the electrical equivalent of the movements and interchanges of the molecules? Let us take, again, the case of friction between two pieces of wood: is it not possible that the friction is the electrical attraction which results from the endeavor to move the adjoining particles of wood in the two pieces asunder? Let us remember, in our endeavor to connect the phenomenon of superficial energy with electrical manifestations, that the friction between two surfaces is modified by keeping these surfaces at a difference of electrical potential. In Edison's motophone, by means of which the voice of one speaking in New York could be made audible to this audience, we see this exemplified in a very striking manner. A platinum point connected with one pole of a battery rubs upon a revolving cylinder of chalk, which is simply moistened with water and is connected with the opposite pole of the battery. The friction between the two is modified in unison with the changes in electrical potential of the battery; and a diaphragm in connection with the platinum point responds to these changes in the friction, and therefore to a transmitter placed anywhere in the electrical circuit.

My own studies have been chiefly in the direction of thermo-electricity, and in the subject of the electrical aspect of what we call superficial energy. I think there is a great field here—in which a large crop of negative results can be reaped—but these negative results I can not regard entirely as thistles. I have tried the following experiment, on the hypothesis that an electrical difference of potential in changing the relations of molecules might modify the heat that is radiated from a surface. I have endeavored to discover whether an electrical current first cools a conductor before it heats it, as we might expect if the molecules being restrained in any way could not radiate as much energy into space as they could under the same difference of temperature, when not submitted to the action of an electrical difference of potential. I have reaped only a thistle so far from this investigation, but I shall

continue it. I have deposited copper in the magnetic field and outside the magnetic field, and have endeavored to ascertain the thermoelectric relations of these layers of copper, and have apparently discovered—I say apparently, for such experiments require a large number of trials, and I have made thus far only a limited number—that there is a difference of superficial energy between the surface in which the molecules of copper have been subjected to a strong attractive force while they were being deposited, and those molecules which have been only under the influence of ordinary gravitation force.

The experiments which I have tried have continually deepened in me the belief that any change in the state of aggregation of particles—in other words, any change which results in a modification of attracting force—whether gravitative or the commonly called chemical attracting forces, results in an electrical potential; and, conversely, that the passage of electricity through any medium produces a change of aggregation of the molecules and atoms. Professor Schuster, in a late number of "Nature" (July 3, 1884, page 230), gives some of the results of his recent investigation of gases subjected to electrical discharges, and believes himself justified in making the following hypothesis: "In a gas the passage of electricity from one molecule to another is always accompanied by an interchange of the atoms composing the molecule; the molecules are always broken up at the negative pole," and in his comments upon this law he remarks that a molecule of mercury consists of a single atom; but mercury has a very brilliant spectrum: this would seem to militate against the hypothesis. On the other hand, if an essential part of the glow discharge is due to the breaking up of the molecules, we might expect mercury-vapor to present other and much simpler phenomena than other vapors. This is the case, for if mercury-vapor is sufficiently free from air, the electrical discharge through it shows no negative glow, no dark spaces, and no stratifications. In reflecting upon experiments of this nature, can not we believe that, if we could systematically break up the arrangement of the atoms in the molecules of any substance, we could produce a difference of electrical potential? Our instrumental means are probably too coarse to enable us to follow the track of such splitting of the molecules. We are like blind men in a great field of energy striving to ascertain the configuration about us with only three senses—the galvanometer sense, the electrometer sense, and the voltameter sense. Suppose you add to the equipment of such blind men a magnetic sense, or an attractive-force sense. Suppose such a blind man could perceive the equivalence of our thoughts in electrical and magnetic relations, as we now see a manifestation of equivalence of mechanical work when a lighthouse lamp bursts upon our sight. Suppose such a person could become sensible of every change among atoms and molecules. Suppose that the quick passing of what we call life from the body into another shape or state of existence should be sensible as a reaction in

electrical and magnetic effects. Such a person could then see the quick ebb and flow and interchanges of attractive forces as we now see the play of colors. Have you ever reflected that we may possibly have some day an electrical spectrum—perhaps I should call it an attracting-force spectrum—in which the electro-magnetic manifestations of energy shall be spread out and differentiated, just as that part of the energy which we receive from the sun and which we call light and heat is now dispersed in the visible solar spectrum? We regard to-day the manifestations of the different colors of bodies—the tints of the objects in the room—as the visible expression of the great law of conservation of energy. The energy which we have received from the sun is making interchanges and is modified by the different molecular structure of the different objects. Thus, a red body has absorbed, so to speak, certain wave-lengths of energy, and has transmitted or reflected back only the red or long waves of energy. The rest of the energy has been devoted to molecular work which does not appeal to us as light or even in certain cases as heat. If we suppose that radiant energy is electro-magnetic, can not we suppose that it is absorbed more readily by some substances than by others, that its energy is transformed so that with the proper sense we could perceive what might be called electrical color; or, in other words, have an evidence of other transformations of radiant energy other than that which appeals to us as light and color?

I have thus far conducted you over a field that, in comparison with what lies before us, seems indeed barren and churlish of results. Have we, then, nothing upon which we can congratulate ourselves? I can only reply by pointing to the rich practical results which you can see in the fine electrical exposition which we owe to the energy and liberality of the citizens of Philadelphia. Although we must glory in this exposition, it is the duty of the idealist to point out the way to greater progress and to greater intellectual grasp.

Perhaps we have arrived at that stage in our study of electricity where our instruments are too coarse to enable us to extend our investigations. Yet how delicate and efficient they are! Compare the instruments employed by Franklin, and even by Faraday, with those which are in constant use to-day in our physical laboratories. Franklin, by the utmost effort of his imagination, could not conceive, probably, of a mirror-galvanometer that can detect the electrical action of a drop of distilled water on two so-called chemically pure platinum plates, or of a machine that can develop from the feeble magnetism of the earth a current sufficiently strong to light the city of Philadelphia. Let him who wanders among the historical physical instruments of many of our college collections stand before the immense frictional electrical machine of Franklin's day, or gaze upon the rude electrometers and galvanometers of that time, and contrast Franklin's machine with the small Toepler-Holtz electrical machine which with a tenth

of the size gives a spark ten times as strong as Franklin's; or the electrometers and galvanometers of Faraday with the mirror-galvanometers and electrometers of Sir William Thomson. Yet, at the same time, let such an observer think of the possibilities of the next fifty years, for the advance of science is not in a simple proportion to the time, and the next fifty years will probably see a far greater advance than the one hundred years since the date of Franklin's electrical work has seen. Is not the state of our imagination like that of the shepherd-boy who lies upon his back, looking up at the stars of heaven, and trying to imagine what is beyond the stars? The only conclusion is that there is something far more than we have ever beheld. Is not the physicist of the future to have instruments delicate enough to measure the heat equivalent of the red and the yellow, the blue and the violet rays of energy?—instruments delicate enough to discover beats of light as we now discover those of sound—an apparatus which will measure the difference of electrical potential produced by the breaking up of composite grouping of molecules? The photographer of today speaks, in common language, of handicapping molecules by mixing gums with his bromide of silver, in order that their rate of vibration may be affected by the long waves of energy. Shall we not have the means of obtaining the mechanical equivalent of such handicapped vibrations? Or, turning to practical science, let us reflect upon the modern transmitter and the telephone, and contrast these instruments with the rude, so-called lover's telephone, which consists of two disks connected by a string or wire. What an almost immeasurable advance we see here! Would it not have been as difficult for Franklin to conceive of the electrical transmission of speech as for the shepherd-boy to conceive of other stars as far beyond the visible stars as the visible stars are from the earth?

Yes, we have advanced; but you will perceive that I have not answered the question, which filled the mind of Franklin, and which fills men's minds to day, "What is electricity?" If I have succeeded in being suggestive, and in starting trains of thought in your minds which may enlighten us all upon this great question, I have indeed been fortunate.

CHILIAN VOLCANOES, ACTIVE AND EXTINCT.

By KARL OCHSENIUS.

THE products of the extinct and the still active volcanoes of Chili, of which Pissis enumerates not less than seventy, are of contemporary origin with the diluvial and alluvial strata of the country. Of the gaseous emissions of their craters, it need only be mentioned that, as in all American volcanoes, chlorine is weakly represented. The

vapors consist chiefly of carbonic acid, sulphur compounds, and water. The present solid products do not differ greatly in composition from the trachytes of the past. Audesite, or a feldspathic mineral very nearly like it, is an important constituent of the porphyritic lavas of both active and quiet volcanoes. Olivine is found in the older and in the more recent lavas of Descobezado, Antuco, and Osorno, as well as in those of Juan Fernandez, and very probably in the liquid outflows of all the other craters. Other lavas occur, among them obsidian, pearl-stone, pitch-stone, and pumice, the last being quite abundant in the Cordilleras of Talca and Chillan. Lapilli cover the eastern flank of Osorno to a depth of about sixteen feet, and through it rose as late as 1851 the great, strong-limbed trunks of dead trees, whose thickness indicated an age of about one hundred and fifty years, while it had been about fifty years since the last eruption of the mountain. But it was a laborious task to trace the lava-stream under the flourishing new growth that had taken root in the weathered surface and in the crevices of the hard deposit.

Of the still active volcanoes, we may say that Atacama emitted smoke after the earthquake of May, 1877. The group of San José was active in 1833, threw rocks into the valley of Pinquenes in 1843, and has been again active since the 2d of March, 1881. Numerous crater-openings, with ancient lava-flows, are found in the same region. Tinguiririca, to the south of this region, consists almost wholly of trachyte, and has several solfataras about five thousand feet below its summit, whence issue vapors having a temperature of 194° ; its thick deposit of sulphur has caused it to be given the name of Morro de Azufre, or Sulphur Mountain. More important still is the volcano of Petesoa, at the outbreak of which, on the 3d of December, 1762, the district was desolated with lava and ashes, and the Rio Lontue was dammed up for ten days. Its last eruption, in February, 1837, was followed by destructive floods in the lower-lying regions, caused by the sudden melting and precipitation of the snows from its summit. An immense horizontal ice-cap now lies in the crater, whence rise vertically isolated columns of smoke that can be seen from a considerable distance. Beyond this is the volcanic center of Descobezado, in the southern part of which a solfatara opened in 1847 that kept the district trembling for many years.

The present region of active commotion begins at 36° 50′ with the volcano of Chillan. A new crater opened northeast of the principal peak of this mountain on the 2d of August, 1861, the flow from which melted the snow and caused great floods. The streams, saturated with ashes, became rivers of mud, and covered the plains with a coating of black. The crater did not become quiet for a year, and then only to break out again in 1864 with increased violence. The dark column of smoke that rose from the crater was visible for miles around, the ash-rain was more formidable than in 1861, and the detonations were

heard and window-sashes were shaken at Concepcion. After a short period of rest, in January, 1865, its activity was again resumed. Antuco is only a few miles south of Chillan. It was visited by Pöppig in 1827, and by Domeyko in 1845, while it was in full activity, and it still sends up faint columns of smoke. The Imperial, or Yaima, in Araucania, was in action in 1852 and 1864, but has since not given any sign of an eruption. An eruption was observed in Villarica about 1860, but nothing since; and the fact that the snow on the top of the mountain does not exhibit any marks of change indicates that its forces are weak. Next to this volcanic center comes Osorno, to which may be added others farther south that have not yet been accurately observed. Among these is one at the southern end of Middle Island, in the Strait of Magellan, which the men of the English ship-of-war Penguin saw at the end of 1877 in full activity. Heavy subterranean rumblings are no rarity in any part of Chili.

In all only ten known Chilian craters can be pronounced with certainty to be now active volcanoes. Obviously the neighborhood of these subterranean furnaces can not be regarded as belonging to the quiet regions of the earth. No part of the earth's surface is so prolific of earthquakes as the western half of South America; and here they are more frequent and severe on the Pacific coast than on the eastern side of the Andes. On this coast they are often accompanied with scenes of horror and woe that surpass description. To the direct consequences in the loss of life and the destruction of buildings are frequently added the ravages of fire breaking out in the ruins and consuming all that has not been already crushed. The seaport towns are exposed to a still further danger of destruction by the rushing tidal-wave which follows the extraordinary retreat of the waters with which the earthquake phenomena are usually accompanied. These evils and more were suffered in their worst form during and after the earthquakes of March, 1881, with which Mendoza was visited, and August, 1868, which laid waste a considerable stretch of the coast, with many towns.

With these volcanic and seismic phenomena is associated a steady elevation of the Chilian coast, which has amounted, according to the indications of the shore-terraces, to from six metres at Cape Three Mountains, to three hundred and ninety-seven metres at Concepcion, within the present geological period. Darwin has averaged the rate at about seventeen centimetres a year. The Island of Santa Maria, in the northwest of the Bay of Arauco, rose three metres during the earthquake of 1835, but afterward sank to its old level. Depressions also seem to have taken place in former periods. The elevating force is more intensive in the Chilian Andes than in the neighboring countries, and, as it is still in operation, it is destined probably to carry the loftiest peaks of the Cordilleras to a still greater height. The frequent occurrence of the ending *huapi*—Indian for island—in the names of

promontories, indicates that many former islands are now connected with the mainland. The islands of Imeleb and Quehui, in Chiloe, are at present separated only at high water, and appear to be approaching a permanent union.—*Translated for the Popular Science Monthly from Die Natur.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXXVIII.—COUNT RUMFORD'S COOKERY.

IN my last I referred to Rumford's anticipation of the results of modern chemical analysis in his selection of the materials for his economical feeding of the poor of Munich; but, as may be supposed, all his theoretical speculations have not been confirmed. The composition of water had just been discovered, and he found by experience that a given quantity of solid food was more satisfying to the appetite and more effective in nutrition when made into soup by long boiling with water. This led him to suppose that the water itself was decomposed by cookery, and its elements recombined or united with other elements, and thus became nutritious by being converted into the tissues of plants and animals.

Thus, speaking of the barley which formed an important constituent of his soup, he says: "It requires, it is true, a great deal of boiling; but, when it is properly managed, it thickens a vast quantity of water, and, as I suppose, *prepares it for decomposition*" (the italics are his own).

We now know that this idea of decomposing water by such means is a mistake; but, in my own opinion, there is something behind it which still remains to be learned by modern chemists. In my endeavors to fathom the *rationale* of the changes which occur in cookery, I have been (as my readers will remember) continually driven into hypotheses of hydration, i. e., of supposing that some of the water used in cookery unites to form true chemical compounds with certain of the constituents of the food. As already stated, when I commenced this subject I had no idea of its suggestiveness, of the wide field of research which it has opened out. One of these lines of research is the demonstration of such true chemical hydration of cooked gelatine, fibrine, cellulose, casein, starch, legumin, etc. That water is *with* them when they are cooked is evident enough, but that water is brought into actual chemical combination with them in such wise as to form new compounds of additional nutritive value proportionate to the chemical addition of water demands so much investigation that I have been driven to merely theorize where I ought to demonstrate.

The fact that the living body which our food is building up and

renewing contains about eighty per cent of water, some of it combined, and some of it uncombined, has a notable bearing on the question. We may yet learn that hydration and dehydration have more to do with the vital functions than has hitherto been supposed.

The following are the ingredients used by Rumford in "Soup No. 1":

	Weight, avoirdupois.		Cost.		
	lbs.	ozs.	£	s.	d.
4 viertels of pearl-barley, equal to about 20¼ gallons........	141	2	0	11	7½
4 viertels of peas..................................	131	4	0	7	3¼
Cuttings of fine wheaten bread..........................	69	10	0	10	2¼
Salt...	19	13	0	1	2½
24 maass, very weak beer, vinegar, or rather small beer turned sour—about 24 quarts..............................	46	13	0	1	5½
Water about 560 quarts.................................	1,077	0	....		
	1,485	10	1	11	9
Fuel, 88 pounds of dry pine-wood..................................			0	0	2¼
Wages of three cook-maids, at 20 florins a year each..................			0	0	3⅜
Daily expense of feeding the three cook-maids, at 10 kreutzers (3 pence ⅜ sterling) each, according to agreement..........................			0	0	11
Daily wages of two men-servants..................................			0	1	7¼
Repairs of kitchen furniture (90 florins per annum) daily..............			0	0	5½
Total daily expenses when dinner is provided for 1,200 persons.....			1	15	2⅜

This amounts to $\frac{422}{1200}$, or a trifle more than one third, of a penny for each dinner of this No. 1 soup. The cost was still further reduced by the use of the potato, then a novelty, concerning which Rumford makes the following remarks, now very curious: "So strong was the aversion of the public, particularly the poor, against them at the time when we began to make use of them in the public kitchen of the House of Industry in Munich, that we were absolutely obliged, at first, to introduce them by stealth. A private room in a retired corner was fitted up as a kitchen for cooking them; and it was necessary to disguise them, by boiling them down entirely, and destroying their form and texture, to prevent their being detected." The following are the ingredients of "Soup No. 2," with potatoes:

	Weight, avoirdupois.		Cost.		
	lbs.	ozs.	£	s.	d.
2 viertels of pearl-barley..................................	70	9	0	5	9½ $\frac{3}{2}$
2 viertels of peas..................................	65	10	0	3	7⅝
8 viertels of potatoes..................................	230	4	0	1	9 $\frac{2}{11}$
Cuttings of bread..................................	69	10	0	10	2 $\frac{4}{11}$
Salt..................................	19	13	0	1	2½
Vinegar..................................	46	13	0	1	5½
Water..................................	982	15	....		
Fuel, servants, repairs, etc., as before..................	....		0	3	5 $\frac{5}{12}$
Total daily cost of 1,200 dinners..................................			1	7	6⅜

This reduces the cost to a little above one farthing per dinner—$1\frac{1}{40}$ exactly.

In the essay from which the above is quoted, there is another account, reducing all the items to what they would cost in London in November, 1795, which raises the amount to $2\frac{3}{4}$ farthings per portion for No. 1, and $2\frac{1}{2}$ farthings for No. 2. In this estimate the expenses for fuel, servants, kitchen furniture, etc., are three times as much as the cost at Munich, and the other items at the prices stated in the printed report of the Board of Agriculture of November 10, 1795.

But since 1795 we have made great progress in the right direction. Bread then cost one shilling per loaf, barley and peas about fifty per cent more than at present, salt is set down by Rumford at $1\frac{1}{4}d.$ per pound (now about one farthing). Fuel was also dearer. But wages have risen greatly. As stated in money, they are about doubled (in purchasing power, i. e., real wages, they are threefold). Making all these allowances, charging wages at six times those paid by him, I find that the present cost of Rumford's No. 1 soup would be a little over one halfpenny per portion, and No. 2 just about one halfpenny. I here assume that Rumford's directions for the construction of kitchen fireplaces and economy of fuel are carried out. We are in these matters still a century behind his arrangements of 1790, and nothing short of a coal-famine will punish and cure our criminal extravagance.

The cookery of the above-named ingredients is conducted as follows: "The water and pearl-barley first put together in the boiler and made to boil, the peas are then added, and the boiling is continued over a gentle fire about two hours; the potatoes are then added (peeled), and the boiling is continued for about one hour more, during which time the contents of the boiler are frequently stirred about with a large wooden spoon or ladle, in order to destroy the texture of the potatoes, and to reduce the soup to one uniform mass. When this is done, the vinegar and salt are added; and, last of all, at the moment that it is to be served up, the cuttings of bread." No. 1 is to be cooked for three hours without the potatoes.

As already stated, I have found, in carrying out these instructions, that I obtain a *purée* or porridge rather than a soup. I found the No. 1 to be excellent, No. 2 inferior. It was better when very small potatoes were used; they became more jellied, and the *purée* altogether had less of the granular texture of mashed potatoes. I found it necessary to conduct the whole of the cooking myself; the inveterate kitchen superstition concerning simmering and boiling, the belief that anything rapidly boiling is hotter than when it simmers, and is therefore cooking more quickly, compels the non-scientific cook to shorten the tedious three-hour process by boiling. This boiling drives the water from below, bakes the lower stratum of the porridge, and spoils the whole. The ordinary cook, were she "at the strappado, or all the racks in the world," would not keep anything barely boiling

for three hours with no visible result. According to her positive and superlative experience, the mess is cooked sufficiently in one third of the time, as soon as the peas are softened. She don't, and she won't, and she can't, and she sha'n't understand anything about hydration. "When it's done, it's done, and there's an end to it, and what more do you want?" Hence the failures of the attempts to introduce Rumford's porridge in our English workhouses, prisons, and soup-kitchens. I find, when I make it myself, that it is incomparably superior and far cheaper than the "skilly" at present provided, though the sample of skilly that I tasted was superior to the ordinary slop.

The weight of each portion, as served to the beggars, etc., was 19·9 ounces (one Bavarian pound); the solid matter contained was 6 ounces of No. 2, or $4\frac{3}{4}$ ounces of No. 1, and Rumford states that this "is quite sufficient to make a good meal for a strong, healthy person," as "abundantly proved by long experience." He insists, again and again, upon the necessity of the three hours' cooking, and I am equally convinced of its necessity, though, as above explained, not on the same theoretical grounds. No repetition of his experience is fair unless this be attended to.

The bread should *not* be cooked, but added just before serving the soup. In reference to this he has published a very curious essay entitled "Of the Pleasure of Eating, and of the Means that may be employed for increasing it," the discussion of which must be postponed until my next, together with the details of the more luxurious *menu* of the first company of the Elector's own grenadiers, who were fed upon boiled beef, soup, and dumplings, at the large cost of twopence per day, and other regiments variously fed at about the same cost.

Before concluding this paper, I must add a few words in reference to the amusing *fiasco* of Mr. Albert Dawson, described in No. 139, p. 486. I scarcely thought it necessary in writing for intelligent people to remind them that the length of time which any kind of moist food may be kept varies with the temperature and the place in which it is kept. Most people know that a leg of mutton, which, on the average, should hang for about a week, may advantageously hang for a month or more in frosty weather, and be spoiled if kept at mid-summer in an ill-ventilated place for two days. The fate of Mr. Dawson's porridge is an illustration of this simple principle. Judiciously kept, it becomes slightly sour; this sourness is due to the conversion of some of the starch into sugar, and the acetous fermentation of some of this sugar. The vinegar thus formed performs the function of that supplied by Count Rumford to his porridge. It renders it more digestible, and assists in its assimilation. The reheating of the oatmeal-porridge drives off any disagreeable excess of acid that may have been formed, as acetic acid is very volatile.

Tastes may vary as regards this constituent. For example, my old friend (to whom I referred), the late William Bragg (so well known

in Birmingham, Sheffield, and South America), preferred his porridge when thus soured ; other members of his family say that it lost the original aroma of the oatmeal. Be that as it may, I have no doubt that the ensilaged porridge, ounce for ounce, supplied more nutriment and demanded less work from the digestive organs than the freshly-made porridge. Probably this advantage may be obtainable more agreeably by Rumford's three hours' boiling, and his willful addition of the vinegar.

XXXIX.—COUNT RUMFORD'S DIETETICS.

In the formula for Rumford's soup given in my last, it is stated that the bread should not be cooked, but added just before serving the soup. Like everything else in his practical programmes, this was prescribed with a philosophical reason. His reasoning may have been fanciful sometimes, but he never acted stupidly, as the vulgar majority of mankind usually do, when they blindly follow an established custom without knowing any reason for so doing, or even attempting to discover a reason.

In his essay on "The Pleasure of Eating, and of the Means that may be employed for increasing it," he says : "The pleasure enjoyed in eating depends, first, on the agreeableness of the taste of the food ; and, secondly, upon its power to affect the palate. Now, there are many substances extremely cheap, by which very agreeable tastes may be given to food, particularly when the basis or nutritive substance of the food is tasteless ; and the effect of any kind of palatable solid food (of meat, for instance), upon the organs of taste, may be increased almost indefinitely, by reducing the size of the particles of such food, and causing it to act upon the palate by a larger surface. And if means be used to prevent its being swallowed too soon, which may easily be done by mixing it with some hard and tasteless substance, such as crumbs of bread rendered hard by toasting, or anything else of that kind, by which a long mastication is rendered necessary, the enjoyment of eating may be greatly increased and prolonged." He adds that "the idea of occupying a person a great while, and affording him much pleasure at the same time, in eating a small quantity of food, may perhaps appear ridiculous to some ; but those who consider the matter attentively will perceive that it is very important. It is, perhaps, as much so as anything that can employ the attention of the philosopher."

Further on he adds, "If a glutton can be made to gormandize two hours upon two ounces of meat, it is certainly much better for him than to give himself an indigestion by eating two pounds in the same time."

This is amusing as well as instructive, so also are his researches into what I may venture to describe as the *specific sapidity* of different kinds of food, which he determined by diluting or intermixing them with insipid materials, and thereby ascertaining the amount of surface

over which they might be spread before their particular flavor disappeared. He concluded that a red-herring has the highest specific sapidity—i. e., the greatest amount of agreeable flavor in a given weight of any kind of food he had tested—and that, comparing it on the basis of cost for cost, its superiority is still greater.

He tells us that "the pleasure of eating depends very much indeed upon the *manner* in which the food is applied to the organs of taste," and that he considers "it necessary to mention, and even to illustrate in the clearest manner, every circumstance which appears to have influence in producing these important effects." As an example of this, I may quote his instructions for eating hasty-pudding: "The pudding is then eaten with a spoon, each spoonful of it being dipped into the sauce before it is carried to the mouth, care being had in taking it up to begin on the outside,.or near the brim of the plate, and to approach the center by regular advances, in order not to demolish too soon the excavation which forms the reservoir for the sauce." His solid Indian-corn pudding is, in like manner, "to be eaten with a knife and fork, beginning at the circumference of the slice, and approaching regularly toward the center, each piece of pudding being taken up with the fork, and dipped into the butter, or dipped into it *in part only*, before it is carried to the mouth."

As a supplement to the cheap soup receipts given in my last, I will quote one which Rumford gives as the cheapest food which, in his opinion, can be provided in England: Take of water eight gallons, mix it with five pounds of barley-meal, boil it to the consistency of a thick jelly. Season with salt, vinegar, pepper, sweet-herbs, and four red-herrings pounded in a mortar. Instead of bread, add five pounds of Indian corn made into a *samp*, and stir it together with a ladle. Serve immediately in portions of twenty ounces.

Samp is "said to have been invented by the savages of North America, who have no corn-mills." It is Indian corn deprived of its external coat, by soaking it ten or twelve hours in a lixivium of water and wood-ashes.* This coat or husk, being separated from the kernel, rises to the surface of the water, while the grain remains at the bottom. This separated kernel is stewed for about two days in a kettle of water placed near the fire. "When sufficiently cooked, the kernels will be found to be swelled to a great size and burst open, and this food, which is uncommonly sweet and nourishing, may be used in a great variety of ways; but the best way of using it is to mix it with milk, and with soups and broths, as a substitute for bread." He prefers it to bread, because "it requires more mastication, and consequently tends more to prolong the pleasure of eating."

* Such lixivium is essentially a dilute solution of carbonate of potash in very crude form, not conveniently obtained by burners of pit-coal. I will try the commercial carbonate, and report results in my next, stating quantities and other particulars. I have but just come upon this particular soup receipt for the first time.

The cost of this soup he estimates as follows:

	d.
Five pounds barley-meal, at $1\frac{1}{2}d.$ per pound, or 5s. 6d. per bushel	$7\frac{1}{2}$
Five pounds Indian corn, at $1\frac{1}{4}d.$ per pound	$6\frac{1}{4}$
Four red-herrings	3
Vinegar	1
Salt	1
Pepper and sweet-herbs	2
	1 $8\frac{3}{4}$

This makes sixty-four portions, which thus cost rather less than one third of a penny each. As prices were higher then than now, it comes down to a little more than one farthing, or one third of a penny, as stated, when cost of preparation in making on a large scale is included. I have not yet tried this soup. In reference to the others specified in my last, I should add that I found it advantageous to use a double vessel—a water-bath constructed on the glue-pot principle. Such vessels are sold under the name of "milk-scalders."

The reason of this is, that with our ordinary fireplaces the heat is so great that the liability to char the bottom of the thick porridge is a source of trouble. Rumford's fireplaces were so skillfully constructed, and used with just as much wood-fuel as was required to do the work demanded, and thus this difficulty scarcely existed. I have little doubt that one of the reasons why the thin broth of our workhouses and prisons takes the place of his thick soup is, that the liquid stuff demands no skill nor attention from the officials who superintend and the cooks who prepare it. Their convenience is, of course, sacred.

The feeding of the Bavarian soldiers is stated in detail in Volume I of "Rumford's Essays." Space will permit me only to take one example, and that I must condense. It is from an official report on experiments made "in obedience to the orders of Lieutenant-General Count Rumford, by Sergeant Wickelhof's mess, in the first company of the First (or Elector's own) Regiment of Grenadiers at Munich."

June 10, 1795.—Bill of Fare.

Boiled beef, with soup and bread dumplings.

DETAILS OF THE EXPENSE.

First, for the boiled beef and the soup.

lbs.	loths.		Kreutzers.
2	0	beef	16
0	1	sweet-herbs	1
0	$0\frac{1}{4}$	pepper	$0\frac{1}{2}$
0	6	salt	$0\frac{1}{2}$
1	$14\frac{1}{2}$	ammunition bread cut fine	$2\frac{7}{8}$
9	20	water	0
Total. 13	10	Cost.	$20\frac{7}{8}$

The Bavarian pound is a little less than $1\frac{1}{4}$ pound avoirdupois, and is divided into 32 loths.

All these were put into an earthenware pot and boiled for two hours and a quarter; then divided into twelve portions of $26\frac{7}{12}$ loths each, costing $1\frac{3}{4}$ kreutzer.

Second, for the bread dumpling.

	lbs.	loths.		Kreutzers.
	1	13	of fine Semel bread	10
	1	0	of fine flour	$4\frac{1}{2}$
	0	6	salt	$0\frac{1}{2}$
	3	0	water	0
Total.	5	19	Cost....	15

This mass was made into dumplings, which were boiled half an hour in clear water. Upon taking them out of the water they were found to weigh 5 pounds 24 loths, giving $15\frac{1}{3}$ loths to each portion, costing $1\frac{1}{4}$ kreutzer.

The meat, soup, and dumplings were served all at once in the same dish, and were all eaten together at dinner. Each member of the mess was also supplied with 10 loths of rye-bread, which cost five sixteenths of a kreutzer. Also with 10 loths of the same for breakfast, another piece of the same weight in the afternoon, and another for his supper.

A detailed analysis of this is given, the sum total of which shows that each man received in avoirdupois weight daily:

lbs.	ozs.	
2	$2\frac{44}{100}$	of solids,
1	$2\frac{84}{100}$	of "prepared water,"
3	$5\frac{18}{100}$	total solids and fluids,

which cost $5\frac{11}{48}$ kreutzers, or twopence sterling, very nearly. Other bills of fares of other messes, officially reported, give about the same. This is exclusive of the cost of fuel, etc., for cooking.

All who are concerned in soup-kitchens or other economic dietaries should carefully study the details supplied in these essays of Count Rumford; they are thoroughly practical, and, although nearly a century old, are highly instructive at the present day. With their aid large basins of good, nutritious soup might be supplied at one penny per basin, leaving a profit for establishment expenses; and, if such were obtainable at Billingsgate, Smithfield, Leadenhall, Covent-Garden, and other markets in London and the provinces, where poor men are working at early hours and cold mornings, the dram-drinking which prevails so fatally in such places would be more effectually superseded than by any temperance missions which are limited to mere talking. Such soup is incomparably better than tea or coffee. It should be included in the bill of fare of all the coffee-palaces and such-like establishments.—*Knowledge.*

DOMESTIC ARTS IN DAMARALAND.

By Rev. C. G. BÜTTNER.

THE peoples with whom missionaries have occasion to become acquainted in Damaraland belong to different races; and the materials for a fair ethnological museum might easily be collected at any of the more important places. The agricultural Ovambos and the nomadic Hereros and Ovambandierus belong to the Bantu race, the Namaquas and Bushmen to the yellow Hottentot stock, while the tribe called the mountain Damaras are a black people of doubtful origin. But although these peoples differ variously in their manners and customs, yet the general circumstances of their life are such that they exhibit only a few differences in their technical accomplishments and trade usages. The desert character of the country, which furnishes only scanty means of subsistence, compels a certain meagerness in all that the people undertake. They are contented to have their simplest wants satisfied, and have never found or aspired after elegance. This part of Africa had, moreover, till a few decades ago, preserved its exclusiveness for hundreds and thousands of years. The rainless desert coast offered nothing attractive to the sailor, and even when one had landed on the shore it was almost impossible to penetrate through the wilderness to the interior. As the trade from the interior of the continent likewise hardly reached here, we have to do in this region with a people who until very recently had lived from a remote epoch cut off from the rest of the world. The natives of Damaraland are thus to a certain extent analogous with those primitive people who in prehistoric times lived, as hunters and fishers, in the northern woods, and fought out the struggle for existence in the rudest simplicity.

Little that is really artistic is to be found among them. Vessels are made by every tribe in its peculiar traditional form, by which their origin can be determined at once, and are decorated with a likewise stereotyped zigzag design, which is traced on iron articles with a chisel, and on wooden ones with a burning sharp stick. We may also add that the Bushmen, who are apparently in the lowest degree of civilization, have painted upon the rocks, in both ancient and recent times, hunting scenes representing all kinds of game and hunters in various situations, which betoken considerable talent in grasping and setting forth typical forms. These designs might, in fact, be regarded as works of more civilized Europeans, were it not that they were found in such various parts of the country, and that they were so much alike in their most peculiar features.

One of the striking characteristics of South African art is its deficiency in the perception of the straight and of the right angle. Everything that the people make comes from their hands bent and

oblique. It costs a great deal of trouble to teach a servant even to put a chair straight against the wall. If his attention is called to the fact that things are not in order, he will at once proceed to make them more crooked and askew than they were before. It is almost impossible to teach them European trades like that of the carpenter, in which straight lines are essential; but they succeed well in giving symmetrical forms to any rounded or free handwork.

The making and use of fire may be regarded as one of the primitive arts of mankind. Like the ancients, the Damaras regard fire as something handed down from their ancestors, to be carefully preserved. Every Herero *werst* has its sacred fire, which must never be extinguished, and which is considered the central point of the tribe and the village. There is the chief's own place, the sacred objects are kept by the fire, councils are held and judgments are delivered at it, the venerable ceremonial acts are consummated with its ashes, and from it are taken the coals with which fires are kindled in other houses. Those who go out with the herds to the cattle-stands take with them a brand from the sacred fire; and when a chief dies without direct heirs, or when the sovereignty passes to another line, then the old fire is put out and new fire is brought from the *werst* of the new chief. All the members of a single family or tribe regard themselves as sitting around one fire.

The care of the fire is intrusted to the oldest unmarried daughter of the chief, or, if he has no such daughter, to the maiden nearest related to him. If, by any accident or misfortune, it is extinguished, it must not be relit from another fire, but must be made anew from the beginning. For this purpose two straight sticks of any readily burning wood are taken. A hollow is made in one of the sticks, in which the sharpened end of the other one may be twirled, and some punk or half-rotten wood is put in a groove cut to hold it, to serve as tinder. This stick is held to the ground by the knees, while the other one is turned rapidly back and forth between the open hands. When a spark appears, it is directed upon the tinder, which is then readily blown into a flame. Thus, it is not the rubbed stick, but the tinder, that gives the flame. The natives dislike this work very much, and when on a journey, if they have no other fire apparatus, they take an ignited stick with them, the fire of which they skillfully keep glowing for a long time. At the present time, the Africans, far into the interior, are acquainted with the use of steel and flint and of matches; Jönköping's paraffine-lighters have probably penetrated farther into the heart of Africa than any European explorer. There is no evidence that the people knew anything of the steel and flint before they became acquainted with Europeans; and I have never seen a fire-steel that was made by a native smith. Besides cooking food and warming and lighting the huts, fire is employed for the felling of large trees and the splitting of stones. In the former case, the fire is built around

the root of the tree, and kept burning till the tree falls. One man can attend a considerable number of such fires, so that the work, as a whole, may go on quite fast. Stones which it is desired to remove from the road are split by the aid of fire, and wells are bored through the rock sometimes to the depth of thirty feet or more.

Hardly any stone implements are used by the Africans, and no trace of a stone hammer or a stone knife has been found in the country. The nearest approach to anything of the kind is when the Bushmen and mountain Damaras occasionally bore through a stone, and load their digging-sticks with it. The stick, having been pushed through the hole till the weight is about at its middle, is grasped with one hand below the stone, and with the other hand above it; and is used more advantageously, just as better work can be done with a heavy crow-bar or mattock than with a light one. These stones are of a similar shape with those that are used for net-weights, but are considerably heavier. Fire-wood is broken up by throwing heavy stones upon it. Long stones seem better adapted to this purpose than others, and, when one peculiarly fitted for the work is found, it is generally kept. Flat stones are employed as lower millstones, and a convenient round stone is looked for with which to do the grinding. So far as I know, no art is applied in shaping the millstones, but the upper one naturally becomes more rounded and the lower one more hollow by use, and both are thus better adapted to their purpose. Old grinding-stones are, therefore, more highly prized than new, unused, and rough ones. These grinders resemble to a hair those that were formerly used by the northern peoples. Small, longish stones are used as hammers, but without any handle, being held directly in the hand. The native smiths now prefer the large bolts with which wagon-tongues are fastened; but stones were formerly used exclusively when native metallurgic art was not competent to produce iron tools adapted to hammering.

The use of clay in pottery is well known in Africa, and the potters are familiar enough with the places where the best material can be found. The pots that I have seen have the form of an egg, and will not stand without a support. Before the natives learned from the Europeans to put feet under their vessels, they laid stones around the bottom. The pots were made with the free hand, without a wheel, by adding to a ball of nearly dry clay a roll of similar clay, and then welding the two together, and smoothing them with the moistened hand; then another roll, and another, till the sides of the vessel were extended far enough; and the marks of the joints between the added rolls could usually be distinguished in the finished vessel. The Hereros characterize the method of this process quite strikingly in their expression "to build up a pot," for "to make one." The vessels are never glazed, but, as the people are not particular about cleanliness, they soon become water-tight. They are burned only as much as can

be done in an open fire. Pots of this kind are, however, not much used in Damaraland, iron pots of European manufacture being preferred. Other vessels than cooking-vessels being made of wood, the potter's industry of the country is in a course of rapid extinction.

Iron and copper were the only metals known to the natives before the arrival of the Europeans, and they were both called in the Herero language by the same name. The civilized Hereros now use foreign words for copper, silver, and gold, while lead has received its name from the bullets into which it is cast. The pastoral tribes of the Hereros and Ovambandierus have but few smiths of their own, but are served by itinerant smiths from other tribes, who wander around, working in small companies, among the chiefs, till they have earned enough cattle to justify them in returning to their homes. Sometimes they are political refugees who have excited the anger or jealousy of their chiefs in Ovamboland, and are compelled to turn their backs upon their homes till a change of dynasty takes place. These Ovambo smiths brought iron from their native country, where the art of extracting that metal and copper from the ores is understood, and rich ores are found. Iron could formerly be got in Ovamboland only at the cost of great labor, and the smith then had to carry his store on his back some fifteen or twenty days' journey. The metal, therefore, commanded a very high price. As late as about 1840, a simple bracelet of iron wire was an adequate guest's present, and a large fat wether could easily be bought with a span of the old hoop-iron with which trunks were bound. The natives were greatly astonished at seeing the costly metal wasted by the Europeans in boot-nails. Iron had thus the value of a precious metal, and, rusting and changing but little in the dry climate, was worn in ornaments by the Hereros, while other tribes preferred copper and brass. The native smiths now use European iron, and seek out good steel, such as is found in files and bayonets. But iron forged in the old-fashioned way into ornaments and weapons has still considerable value.

A smith's bellows common to all the Bantu peoples consists of two wooden vessels, out of which the air is pumped into the fire through the long, straight horns of the African gemsbok. The Hottentot bellows, which is more generally used in Damaraland, is a long bag, usually made from the whole hide of a goat, at the middle and the end of which is an air-valve. The fore half of the skin is held to the ground and weighted with a stone to press upon the air, which is pumped in by means of the alternate compression and expansion of the rear half. From the point of the bellows, or neck-end of the hide-bag, the air is conducted through a clay pipe or a gemsbok-horn, or, in later times, a gun-barrel, to the fire. It is obvious that only light work can be done with such a bellows; at most, bringing a small piece of iron to a red heat. For tongs, the smiths generally use a bullet-mold, while they formerly took two straight pieces of iron, or,

if they had nothing better, two sticks. A stone is made to serve as an anvil. Iron beads and bracelets are made, and the last are adorned with some neatly engraved pattern. Some of the rings of which I have obtained specimens, which have been simply turned upon a stick and welded, would do credit to a European smith. I have seen copper bracelets that had been bent into a spiral shape resembling a coiled snake. The Hottentots like bracelets and rings made by winding brass and copper wire around a coil of leather, in which patterns are produced by mingling wires of different sizes. The Ovambos wear heavy copper rings on their ankles, which are bent upon the legs. One of these rings, which I presented to the Ethnological Museum in Berlin, is very like some of the rings that are found in northern graves. Other works of the South African smith's art are iron lances having the handles ornamented with an ox-tail flier, barbed arrow-heads, double-edged knives and daggers, the latter without guards; and axe and hatchet blades, which are now used in making wooden articles. Almost everything that is made of wood has to be formed from a single piece, for the art of permanently joining two pieces of wood together seems to be wanting among these people. They do not know how either to dovetail, nail, or glue. Hence, in making every article of wooden-ware, whether a spoon or a boat, the artificer has to be governed by the shape and size of his block. The knife-cases and dagger-sheaths are thus made from one piece; and, as the natives have no boring-tools, one of the cheeks of the sheath has to be cut entirely away, excepting thin strips at the corners to hold the blade in its place. The tools used for hollowing out the wooden vessels are a double-adze, or *tribill*, and an axe worked like a chisel. The adze is a triangular iron, shaped so as to present a knife-edge at one end and a point at the other, and is driven through a hole previously burned in the handle, perpendicularly to it, and in such a manner that every blow made with the tool in hewing shall drive it tighter up. The outside of the vessel is shaped with the adze; all is done by eye, without any such aids as the square or compass, and nothing but the hands to hold the block while it is hewed. But the work is performed with a skill and finish that would do credit even to a shop provided with the implements of civilized artisans. This kind of work appears to belong to the chief, and to be regarded as a kind of state function; for, although it may not be done by the chief himself, it is generally performed under his eye, at the village fire, and is submitted to his inspection from time to time while it is going on. If a wooden vessel becomes cracked, it is not thrown away, but is mended, if possible, by sewing up, or patching with fibers of tough grass, or of the fan-palm common in the country, and then smeared with cow-dung, a substance which the Africans do not regard as unclean, to make it milk-tight. Round-headed canes, long and short throw-sticks, and arrows of hard wood are carved with knives.

The eastern Bechuanas and Caffres are fond of carving canes entwined with snakes. While the cane and snake are made from the same piece, the latter is attached only at a few points, so that the mass of its body is left free. The wooden arrows, which have barbed heads, are used for shooting small game. Sometimes wooden arrow-heads are set loose in shafts of reed, so that, when the latter are drawn out, the points shall remain in the wound.

Rush mats are made by the Hottentots, by stringing rushes on a needle and drawing a thread through them. Threads and cords are made from bark-fibers and fibers of aloe without the aid of any tools, simply by twisting them with the flat hand upon the leg. Baskets are made from roots and from palm-leaves, where that material can be had. The foundation of the basket is laid with a spiral of thick braid, as our straw hats are begun, to which rings are added and connected as compactly as possible by cords, and the vessel is made tight enough to hold milk or any other fluid. Skins are dressed by saturating them with fat, and rubbing and kneading them with the hands and feet till they are perfectly pliable; or, if they are very thick, by beating them with a club. Straps are prepared by cutting them out spirally from the skin, so as to get as great a length as the leather will afford. The strap is then slung over a stout limb, so that its ends will come as near to the ground as they will reach; the ends are weighted with a stone, and the doubled strap is twisted up, with the aid of a lever, as tightly as possible, till the stone is raised nearly up to the limb. The lever is then drawn out, and the strap is allowed to untwist and retwist itself again and again. This process is repeated, with oiling, for several days, till the strap becomes quite pliable. Skins which are to be made into bottles are taken off from the carcass with as little cutting as possible, the knife being generally used only at the tail and the feet, after which the hide is pulled off literally over the ears. The bottles are then tanned in the common manner, but are only used for keeping dry articles. The Hottentots employ bark in tanning skins, but it is possible they learned the art from the Europeans.

Skins are also used for clothing, without any making up, but worn just as they are left after dressing, with at most only a little shell-embroidery, but are not sewed to one another, except when they are to be used for bed-coverings or curtains. Thorns, which grow on the acacias and mimosas, of every shape and size that can be desired, are employed as needles, and for thread the long sinews from the backbones of slaughtered animals, which are stiff enough to be pushed through the hole made by the thorn without any further aid than their own rigidity. In the ante-European times pins, buckles, and hooks were unknown, and the only means of holding the garment upon the person was by a belt, or the hands; or, if a whole sheep-skin was worn as a cloak, the head was left to hang down behind, and the hind-legs were brought over the shoulders and tied.

Shoes were made from the thicker hides. The Hereros wore sandals with long points in front and behind, projecting beyond the foot. The Namaquas wore something more nearly approaching shoes, in which they attached the upper leather to the sole with a narrow strap. The work being done by the eye, without measuring or fitting, it often happened that the shoes of a pair were of different sizes and shapes. I have never seen anything made of bone in South Africa except little mat-needles among the Namaquas, mouth-pieces of pipes, and snuff-boxes. The Namaquas also make pipes from serpentine. Small bones are worn as ornaments and amulets; and little children sometimes have a few bones hanging from their belts for playthings.—*Translated for the Popular Science Monthly from Das Ausland.*

OLD CUSTOMS OF LAWLESSNESS.

By Herr M. KULISCHER.

GRIMM tells, in his "Legal Antiquities of Germany," of a peculiar custom which existed, in the duchy of Carinthia, during the election of a new duke, till a comparatively recent period. So long as affairs continued unsettled, relates the narrative from which he quotes, the Gradnecks had the right, which had come down to them from of old, to mow as much hay as they could, robbers to plunder, and pirates to ravage the land at will with impunity, unless peace was made with them. Leoben states that this custom arose in the time of Charlemagne, about A. D. 790, under Duke Ingo, but further than that its origin is still in the dark. It is impossible to explain the existence of so barbarous a practice as this, by reference to any motive of expediency, as we are usually able to do with the phenomena of political and social life. An outbreak of outrage could evidently respond to no real social want; least of all a usage that must have been destructive, for the time being, of all fundamental conditions of social life, and of the material well-being of the population, and that could not have failed to be detrimental to the maintenance of social order when law was supposed to be again in force. The case is evidently one of a survival from a former period, a relic, perhaps, of some older condition of society. We may probably find a little light concerning its origin in the study of some of the savage tribes of the present time, who are believed by many anthropologists to be living in the same grades of civilization which the ancestors of modern civilized nations have passed through.

We learn from African travelers of the existence by custom, in some of the West African states, of a general anarchy and tolerated hostility during the interregnum between the death of a king and the

enthronement of his successor. When the King of Ashantee dies, his women destroy his treasures, and general unrestricted license, robbery, and murder prevail in the country; and a similar season of disorder ensues on the death of the chief in Whydah, Benin, and other states. Waitz remarks, in his "Anthropology of Savages," concerning the duration and extent of this license: "Usage has limited the anarchy to a definite and short time, and it is admitted by all that the disorder in no way works a real dissolution of all social bonds, but is only to be regarded as a sudden relaxation of them which, notwithstanding that all sorts of outrage are let loose, is always controlled by custom, and induces no material damage to society." In Ashantee, the season of unrestraint may last for five days; in other states it may continue for a considerably longer time, as in Loango, where it prevails for several months. In Dahomey, the death of the king is not made known for eighteen months, while the heir, assisted by the two highest officers, reigns in his name during this whole period. The eighteen months seem to mark the time during which a legal anarchy formerly prevailed, though it may now have been done away with.

We have a right to conclude from these facts that a tolerated disorder is an accompaniment of the death of a ruler, and lasts until the accession of a new one. The eighteen months mentioned above were probably originally an interval of that kind; and, although the deceased ruler is now immediately succeeded by another, the latter still reigns, according to a custom transmitted from that time, not in his own name, but in that of his predecessor, who is not regarded as dead, but only as ineffective. A customary anarchy is also said to have prevailed as a form of mourning after the death of a sub-chief among the Maravis—a fact that agrees with the general explanation of the usage incidentally given by Waitz, who remarks that it "appears to be nothing more than the public mourning of the whole country, which inflicts wounds upon itself as individual relatives afflict themselves after the death of a private person." A similar motive possibly prompts the destruction of the king's jewels by his women in Ashantee, and is perhaps re-enforced by a view which has been observed to prevail in earlier stages of civilization, that all that he possesses dies with the owner. Livingstone speaks of a periodical lawlessness among the Banyai, which ceases upon the election of a new chief. A similar custom prevails among the Wahumas of the lake-region, who have in other respects made considerable advances in civilization. These African peoples stand as a rule at a far lower grade of civilization than the one which the people of the duchy of Carinthia had reached while the custom of legal anarchy as described still existed among them. We are able to study the practice more closely among the African peoples, and make a nearer approach to its origin. Among them it does not appear to be connected with the time when the newly chosen chief ascends the throne, but at an earlier period to have lasted

considerably longer than it does now, or during the whole interval that might have elapsed between the death of a ruler and the accession of a new chief. As such an interval is superfluous in hereditary monarchies, where a successor to the throne is always at hand, we must relegate the origin of the custom to that period of the people's life when the chief obtained his office by election. A connection with election is indicated in the case cited by Grimm and confirmed by Livingstone's relation. If the custom continues after the office has become hereditary, it is evidently only as a survival.

The condition of disorder assumed another form in Tahiti, where, upon the death of the chief, the several districts of the nation made sham wars upon one another, which were sure to end in real plundering. This phase of the custom appears to have been an outgrowth of the federative nature of the state. The bond of union between the provinces having been severed, the mutual jealousies, which always prevail between adjoining communities, broke out in force, and found expression in the singular way that we have indicated. Questions were sure to arise, as to which district should nominate the new chief, that would be certain to generate disturbance. The hostile relations would cease as soon as the new chief was chosen and the federal bond was restored; for the several communities would again be members of the same political body, under a common head, and would be compelled to live in at least outward unity. The custom of legal anarchy in this form, then, appears to be a survival from a condition in which neighboring districts waged constant, real wars with each other, and gave to destruction all the property they could get of their rivals; and its existence in countries where the chiefdom has become hereditary may be regarded as a sign that a federative system, with an elective chief, once existed there. Confirmation of this view is afforded by the existence of a tradition among the Ashantees, where the royal dignity is now hereditary, according to which the nation was once a federation of twelve territories.

It is easy to believe that, in view of the periodical disorders to which federatively constituted states are liable, such forms must give way to more solid ones, as soon as the instinctive, mutual hostility of the allied territories is extinguished, under the continuous operation of an associated life; and that the efforts of powerful families to appropriate the chieftainship to themselves as an hereditary possession will find sympathizers among those who dread the return of a temporary legal anarchy as an accompaniment of each new election. It will, moreover, be important, after the hereditability of the royal office has been accepted, to establish the principle of the uninterrupted existence of that office. According to this principle, the throne is never vacant; or, as it is expressed in the English common law, "the king never dies." In Dahomey, this fiction assumes the form that no demise of the royal authority has taken place, and the heir reigns in

the name of the old king. Everything that can suggest anarchy, and lend support to the old custom, is carefully set aside. Neither the election of a new ruler, which is always attended with contentions and excitement, nor the death of the old one, is recognized. If anarchy still survives there, where every measure is taken to prevent it, it is only as a shadow of the past.—*Translated for the Popular Science Monthly from Das Ausland.*

THE OIL-SUPPLY OF THE WORLD.*

I.

IT may be, that if the sages of prehistoric China, or the Magi of Chaldea and other ancient civilizations, could return to enlighten our ignorance, they might prove to have possessed far more scientific knowledge than we give them credit for, with some points of practical application which we marvel to think could ever have been forgotten.

Among many such subjects which from time to time call forth our wonder, one of deep interest at the present moment is that old, old subject of pouring oil on rough waves—a subject which (save by a very few practical seamen who happen to have tested the matter for their own preservation) has only within the last three or four years been recognized as a real thing, of most serious importance to all seafaring folk. Hitherto it has been generally deemed merely a poetic metaphor, with no practical foundation. Isolated facts concerning its use were known, as were also allusions to its properties by such sages as Aristotle, Plutarch, Pliny, and, in later days, Erasmus of Rotterdam, Linnæus, or Benjamin Franklin.

When saintly men such as St. Cuthbert or Adamnanus soothed the angry waves by the outpouring of a little oil, this natural result was of course attributed to their own holiness, and the miraculous efficacy of consecrated oil. And even when in A. D. 1776 Lelyveld, a practical Dutchman, published at Amsterdam his "Essay upon the Means of diminishing the Dangers of the Sea *by pouring out Tar-Oil* or other Floating Matter," an essay followed in A. D. 1798 by a more elaborate statement of "Evidence on the Oil Question," published by Otto at Weimar, the interest temporarily awakened soon subsided, and generation after generation of seafaring men have continued wholly to neglect the use of this simple precaution ; and lamentable indeed is it to peruse the appalling record of each winter's wrecks on our own shores, and to note in how many instances life might probably have been saved, had the strong, brave men, so ready to hazard their lives in order to succor others, bethought them of lightening their task by the use of a few gallons of oil.

* Abridged from "Blackwood's Magazine."

And yet, the time is fast approaching when the now rising generation will wonder at the folly of having ever neglected such a means of salvation ; for the mass of evidence on this subject which has recently accumulated has now compelled attention from the most skeptical, and the experiments so successfully carried out on the stormy coast of Aberdeenshire, at the harbor of Peterhead, have borne fruit far and near.

Some of the fishers who had witnessed them remembered them to good purpose when trying to enter the harbor at Stonehaven, and warned of their danger by the white-crested waves raging on the bar. They had with them only a little colza-oil and a little paraffine for their lamps (*vegetable* and *mineral* oils)—so little that most men would have deemed it mere folly to cast such upon tempestuous waves. But these men had profited by their lesson. One man stood on either bow, and, just as the boat approached the raging surf, they slowly poured out their offering to the waves, which, as if by magic, ceased to break, and rolled on in harmless green billows, which carried the boat safe into port. I have also just heard from Cornwall that a party of Cornish fishers who chanced to be at Aberdeen at the time of the experiments, and there witnessed the stilling of the waves, returned to their own granite-bound coast with the conviction that they had seen something which hereafter it may be well for them to practice.

Now, thanks to the same large-hearted and energetic Scotchman who planned and brought into practical working the oil-breakwater at Peterhead, the men of Kent can tell with wonder of its application to their own harbor of Folkestone, and are eye-witnesses of how quickly, on a very stormy day, a few gallons of oil have calmed the breaking waves, and made the harbor smooth and safe. The London papers, in reporting on these experiments, have stated the general belief that, by this simple use of oil, entrance and egress to Folkestone Harbor may henceforth be made absolutely secure in the severest storms.

In this relation, therefore, apart from all interests of the non-sea-going population, the question of the world's oil-supply assumes a new and enlarged interest. Here it would appear that Nature herself desires to illustrate the question in a most practical manner, and as the field of her demonstration she selects the Gulf of Mexico. About ten miles to the south of the Sabine River, which forms the boundary between Texas and Louisiana, and about a mile from the shore, there exists a natural phenomenon known to sailors as "The Oil-Spot." In fine weather there is nothing remarkable to attract the attention of a stranger ; but when an angry gale from the northeast sweeps the ocean, and great crested waves rise in battle array, this charmed natural harbor reveals itself. No visible boundary divides it from the tempestuous ocean around ; but, within a space two miles in length, *the waters remain perfectly calm,* their only change being that they become turbid and red, as though the oil-bearing mud were stirred up

from below. A broad belt of white foam and towering breakers marks where the mighty waves, rolling shoreward in their might, with all the force gathered in an unbroken sweep of seven hundred miles across the Gulf, are suddenly arrested, and sink down, conquered and powerless, so soon as they come within the mysterious influence of this gentlest of rulers.

Unfortunately, this peaceful haven is very shallow; its depth is variously stated at twelve and eighteen feet, so that only vessels of light burden can here take shelter. But to these, blessed, indeed, is the change of passing suddenly from the wild tossing of the outer ocean to the wonderful calm of this strange harbor, where the weary crew may rest as securely as though within an encompassing coral reef. Indeed, the stranger approaching this wall of breakers would naturally assume it to be caused by a dangerous reef, and would, as a matter of course, seek safety by steering away from it.

We believe that no scientific examination of this so-called Oil-Spot has yet been made. Sailors who have here found refuge state that the bottom is of a soft, soapy mud, into which they can easily push a pole to a considerable depth—a mud which, when applied to deck-scrubbing, is found to be exceedingly cleansing.

That the existence of this little haven is due to a submarine oil-spring there can, we think, be little or no doubt, though we have no positive information of discovery of oil-springs on the seaboard of Louisiana or Texas. We know, however, there are many points around the Gulf where petroleum, asphalt, or naphtha in some form, is found in immense quantities, chiefly in the three eastern States of Mexico—Tamaulipas, Vera Cruz, and Tabasco. In the first of these, inexhaustible beds of asphaltum lie on both banks of the river Thamesi. It oozes in an almost pure state through the sedgy borders of the river, and is collected in boats of light draught, which convey it sixty miles down the stream to the port of Tampico.

In the State of Vera Cruz, asphaltum, naphtha, petroleum, stone-coal, and kindred bituminous substances, are found abundantly along the whole coast-range. Six counties are specified, one being especially rich in these deposits, which are sometimes found pure, sometimes mixed with rock-salt and saltpeter. Dr. Hechler, a scientific German traveler, has described the great asphalt-beds near the village of Moloacan. "The salt-mine," as it is there called, is an isolated conical mountain about twelve hundred feet in height, cracked by earthquakes. On its slopes are a number of pits, some of which are cold and still, others seething and bubbling with much noise and a stifling odor. Some of these seething pits eject masses of liquid asphaltum, which the Indians call *chapopote.* The whole adjacent surface consists of asphalt, partly liquid and partly solid, mingled with rock-salt. External heat and subterranean noises tell of the fires still smoldering within the mountain. Dr. Hechler hazards a suggestion that pos-

sibly some day the mountain-crust will subside, and its site be occupied by a bituminous lake, like the Dead Sea of Palestine.

Masses of this *chapopote* are found floating on the rivers and lagoons, or cast up by the waves all along the Gulf coast, when it is collected for sale, and is of excellent quality—clean, hard, and brilliant. Great beds of this substance are found along the upper waters of the Grijalva River, in the State of Tabasco. The deposits of petroleum are specially noted at El Chapopotito, in the county of Ozuluama, in Vera Cruz.

Though no trace of mineral oil has yet been detected in the rocky regions of Central America, its presence has been abundantly proved on the north of the Southern Continent, where, among the most important of recent discoveries, rank the oil-springs on the shore of Lake Maracaibo, in Venezuela, which, together with the great undeveloped coal-mines and other sources of mineral wealth, promise so rich a future to that now waste and desert country.

The chief features of the country between the Cordilleras and the Rio Zulia are the numerous asphalt-mines and petroleum-fountains which abound all around the base of a chain of low hills which lie between the Rio Zulia and Rio Tara. Two other rivers water this country, the Rio Catatumbo and the Rio Sardinarte, which probably accounts for the luxuriance of the cool, dark forest, that contrives to flourish in a region known to the people of Maracaibo as *El Infierno*, by reason of the multitude of fountains and deposits of petroleum and asphalt.

At one point a raised sand-bank is honeycombed with circular holes, from which gush impetuous streams of boiling water and petroleum. Columns of white steam are also ejected with deafening roar. A careful observer estimated that the flow from one of these streams equaled 5,760 gallons per diem. At present all this good petroleum is soon lost again in the earth, and an immense quantity of inflammable gas also escapes and ignites, playing in weird flashes among the dark treetops. This earth-born lightning is seen by vessels lying off the bar, and is known as *El farol de Maracaibo*. This group of springs lies near the confluence of the Tara and Sardinarte Rivers, which are navigable for small craft of under fifty tons. But petroleum-fountains, deposits of bitumen, asphalt, and other resinous minerals, lie scattered in all directions; and there is abundant proof of the existence of rich coal-seams, which ere long must certainly create a revolution in Venezuelan commerce.

Near San Timoleo the accumulation of asphalt and petroleum is so extensive as to form a large lake, somewhat resembling the celebrated Pitch Lake on the Isle of Trinidad, where a strange, thick, flexible crust of black bituminous matter is said to float on the surface of a fresh-water lake. But, as no one has yet arrived at even estimating the depth of the crust, it is difficult to see how the existence of the

said lake can be proved. All that meets the eye is a level plain of pitch about three miles in circumference, dotted over with patches of vegetation and bushes, and pools of rain-water, wherein women wash and bleach their linen, while men with pickaxes dig out large fragments of hard, resinous pitch, which are carried off in carts, all on the surface of the so-called lake. Though only about a hundred acres of pitch are thus exposed to view, the deposit crops up at several points five or six miles to the north and to the south, and appears to be only covered by a thin layer of soil or sand. The lake lies about eighty feet above the sea. As the place of the Pitch Lake, in these notes on the world's oil-supply, may not be self-evident, I may venture to remind my readers that the definition of petroleum (*petri oleum*, "rock-oil") is "a native liquid bitumen," which is essentially asphalt dissolved in naphtha. So perhaps we shall some day see the people of Trinidad start their own oil-factories. (The neighboring Isle of Barbadoes also contributes its quota to the world's supply of bituminous asphalt.)

There are numerous petroleum-wells actually within the town of Columbia, and, though the oil is of inferior quality and not abundant, the poor collect it in cloths, which absorb the oil, and are then wrung out into jars, and thus they obtain sufficient to light their houses. So long ago as 1824, samples of this "oil of Columbia" were sent to England, France, and the United States, as a remarkable new discovery; but the secret of distillation had not then been discovered, and kerosene and benzine were unknown products, so this South American oil failed to attract attention. In like manner we learn that in remote ages the citizens of Genoa obtained their oil-supply from the wells on the banks of the Taro. And, in the days of Pliny, Sicilian lamps were fed from the oil-springs of Agrigentum; and long before the Christian era the old Romans knew how to turn to account the oil-wells of Zante. Yet no systematic working of any of these wells seems to have been attempted.

Petroleum in some of its varied forms has long been known to exist in many different parts of Europe. In Galicia, Moldavia, and Roumania, it is found in a semi-solidified form, which led to its being named mineral fat or tallow—as in the so-called "tallow-wells." The ozokerite or earth-wax of Galicia is found in great abundance, and of so pure a quality as quite to take the place of beeswax in the manufacture of candles, etc. A considerable number of the population are employed in mining for it, and also in working the industry in all its branches.

So far back as 1873, the annual return of burning-oil and paraffine was valued at a sum equal to £500,000. This was chiefly obtained from the Boryslaw district.

In 1879 an American oil-refiner from Ohio determined to commence work in Galicia on more scientific principles than any hitherto

attempted. He imported first-class machinery and skilled workmen; but the Poles combined against the interloper, and refused to supply his refinery with crude oil, so for a while he actually was driven to import crude petroleum from America. The people finding that he could not be crushed, desisted from their opposition, and the American refiner now works in peace. He estimates the annual production of Galicia at a hundred thousand barrels, but its quality is generally very inferior to that of Pennsylvania; the sinking of the wells is attended with far greater difficulty, owing to the loose character of the soil, and the singular manner in which the rock strata are found tossed about at every conceivable angle. It is also necessary to bore to a far greater depth than in America. But the chief disadvantage of Galician oil is its liability to explosion, owing to the extreme difficulty of separating the benzine and other explosive elements from the illuminating oil. Altogether Galician oil does not sound very desirable.

In Roumania, in the districts of Bacan, Serata, Buzen, and Dambovitza, petroleum has recently been discovered in such large quantities that there is every prospect of its developing into a very important industry. Prussian Saxony has already established extensive bituminous shale-works, for the supply of shale-oil, in the neighborhood of Weissenfels. Wallachia, Sweden, and Switzerland, also possess deposits of bituminous asphalt, which when systematically worked will, doubtless, be turned to good account.

For a moment let us glance at the principal sources of animal and vegetable oil-supply, ere the fountains of mineral oil were revealed for the use and comfort of the human family.

First and foremost, of course, ranked the fish-oils—the well-known train (or *drain*) oil which drained from the blubber of the great Greenland whale (a large whale sometimes yielding fully thirty tons of blubber—each ton representing nearly two hundred gallons of oil. Though the cachalot, or sperm-whale, could never rival the Greenland whale in the quantity of its contribution, it had at least the advantage of quality and variety, since, besides ordinary blubber, it yields a large amount of sperm-oil, and also of spermaceti. Of the latter valuable product, the head alone often yields ten barrels.

Next among oil-yielding fish come the grampus, or dolphin, the porpoise, the shark, the seal, the cod, the herring, and others.

Of animal fats are butter, tallow, lard, goose-grease, neat's-foot oil (prepared from the feet of oxen, and used by curriers in dressing leather), and mare's grease (imported from Buenos Ayres and Montevideo, where a multitude of horses are annually slaughtered for the sake of their hides, tallow, and bones!). In Russia, especially at Moscow, yolk-of-egg oil is in great repute for making soap and pomatum.

Vegetable oils form a very important item in our supplies, inasmuch as oil-seeds to the value of £5,500,000 are annually imported into Britain for crushing purposes, and our exports of oil are roughly

valued at £1,600,000. The export of seed-oil from London, Hull, and Liverpool, in 1880, was 14,508,000 gallons.

Under the head of seed-oils rank linseed, cotton-seed, and castor-oil. Colza-oil, also, is made from mustard, hemp, radish, rape, turnip, and other seeds. Then we have olive-oil and almond-oil. From India comes poppy-seed oil; from the Black Sea, oil of sunflower-seeds. From Ceylon and the Pacific isles comes cocoanut-oil. From Western Africa the palm-nut oil of the oil-palm, and oil of ground-nuts, for use in fine machinery. From Singapore and China we receive kokum-oil and vegetable tallow. About fourteen thousand tons of croton-oil are annually imported for the use of the wool-dressers of Britain.

Besides these, so familiar to ourselves, almost every country has some specialty in oils. Thus, in Southern Russia, tobacco-oil is largely used; in Italy, oil of grape-stones; in China, oil of tea-seed; in India, oil of nutmegs, of seeds of the gamboge-tree, of custard-apple-seed, of cashew-nut, of cardamom, of neam, of margoza, and many others. Brazil, too, has a large number of oils, both animal and vegetable, peculiar to itself.

In this connection, and bearing in mind Lelyveld's essay on smoothing the waves with tar-oil, we note that Great Britain annually imports five million gallons of wood-tar, and that about an equal quantity is made in the country from coal, at the charcoal-works, the gas-works, and the bone-factories.

To M. du Buisson, a Frenchman, is due the credit of first attempting to distill oil fit for burning from the bituminous shales hitherto deemed worthless. He succeeded in his experiment, but the shales of France were not found to yield oil in paying quantities. An effort was then made to apply the same process to the bituminous shales of Dorsetshire, and "Kimmeridge coal" was found to yield a much larger proportion of oily matter. It was, however, found impossible to overcome the noxious smell of the various products; so that this enterprise did not command large success.

About the year 1847 Sir Lyon Playfair discovered a petroleum-spring at Riddings, in Derbyshire, to which he called the attention of Mr. James Young, a Manchester chemist, who proceeded to distill it, thereby obtaining a clear, thin burning-oil, and also a thick lubricating oil. Certain solid crystals floating in the petroleum suggested the presence of paraffine, and the possibility of obtaining a candle-making substance. This resulted in the manufacture of the first two paraffine-candles, and these were lighted by Dr. Playfair, to illustrate the novel subject at a lecture to the Royal Institution, when he foretold that ere long they would become the common light of the country—a prophecy which was very quickly realized, but not from the Derbyshire springs, as these were soon exhausted.

Mr. Young's attention was next attracted by seeing oil dripping from the roof of a coal-mine, which led to further experiments, with

the result that cannel-coal was found to be essentially oleiferous. The discovery near Bathgate, in Linlithgowshire, of a very rich gas-coal, like the celebrated Boghead coal, led to the establishment of a distillery in its neighborhood, the coal being broken up into fragments like road-metal, and heated to a red-heat in cast-iron retorts. A ton of this coal was found to yield about one hundred and twenty gallons of crude oil. This, being subjected to a second distillation, resolved itself into certain proportions of light oil for burning, thick oil for machinery, a small quantity of naphtha, and a large residuum of paraffine, which, when purified with animal charcoal, is transformed into a substance like beautifully white wax.

Great was the interest excited by this discovery; but difficulties were thrown in the way of Dr. Young's obtaining a patent for his invention, as it was proved that many years previously Reichenbach had tried a similar experiment, and, by distilling one hundred pounds of coal, had obtained two ounces of an oil resembling naphtha. Young, however, carried the day, and his now celebrated patent was granted in 1850.

It was not till six years later that any fresh attempt was made thus to utilize the great beds of bituminous shale which are so extensively found in carboniferous districts, but which had hitherto been totally neglected. These have been found to yield from thirty to fifty gallons of crude oil per ton; and great works for the manufacture of mineral oil have been established at many places in England, Wales, and Scotland.

"Greater Britain" was not slow to adopt the new industry started in the mother-country. In 1865 New South Wales discovered among its hid treasures a shale similar to the Boghead coal of Scotland, but considerably richer in oil, and less sulphurous. A sample was brought to Sydney for distillation, and one ton yielded one hundred and sixty gallons of oil. Thereupon the New South Wales Shale and Oil Company was established, and seems to have developed into a very important industry.

America had taken up the subject earlier. In 1854 the Kerosene-Oil Company and several other companies were started to distill oil from coal, and by 1860 upward of fifty factories for this work had been established in various parts of the States.

Then came the discovery of real mineral-oil wells, which so quickly revolutionized the oil-traffic of the world. Here, as in most other cases, we have evidence of the "nothing-new" theory; for, since King Petroleum has asserted his power, men marvel to find traces of ancient workings, proving that by-gone generations had discovered the native oil—so long ago, that very old trees of several centuries' growth have been found growing in the excavated ground. From some strange cause unknown, these oil-seekers had abandoned their work, and (although mineral oils were known to exist in Asia) their presence in

America had been altogether forgotten, when, in 1826, salt-workers who were engaged in boring brine-shafts in Ohio were amazed to find that they had struck oil as well as brine.

Certainly it was known to the Seneca Indians of Pennsylvania that oil flowed from the rocks at various points in the Alleghany Mountains; and a French traveler has recorded a curious incident which he witnessed in 1750, when the tribe assembled for a religious ceremony, at the junction of a small stream with the Alleghany River. The stream was covered with a thick, oily scum, to which, after a solemn oration, the chief applied a lighted torch. Immediately the flames spread over the surface of the water, amid shouts of the red warriors.

In the same district, at the spot now known as Titusville, was a well on the surface of which oil habitually floated; and the Indians, who had long known its healing properties (now so fully recognized in its refined form as vaseline), were in the habit of collecting it by laying their blankets on the glassy surface of both well and stream, thus absorbing the oil, which they then wrung out and stored for the use of the tribe. So early as 1833 an account was published in "The American Journal of Science," describing how certain persons made a living by skimming this dirty-looking and most unfragrant grease with their boards, and then purified it by heating and straining it through flannel, when it was sold under the name of Seneca-oil, as an excellent specific for healing sores of man and beast, and curing sprains and rheumatism.

In 1853 it occurred to Dr. Brewer that this natural oil might be turned to account for lamps, and the Pennsylvania Rock-Oil Company was formed to develop the idea, with very small result, however, till, in the year 1859, Colonel Drake's attention was attracted by the oil which oozed from fissures of the rock all along the stream now known as Oil Creek. He bethought him that since the rock was apparently saturated with this oil, there must surely be a reservoir which, if it could be found and tapped, would yield a far larger supply than that which was so carefully collected by the company. Little, however, did he dream when he first communicated to them his idea, and was by them empowered to work it on their account, what amazing results would attend his experiment.

He commenced sinking a shaft on the artesian-well principle, and had bored to a depth of six hundred feet, when, to his unspeakable delight, he found that he had indeed reached the main supply, and oil was henceforth pumped up at the rate of from four hundred to one thousand gallons daily. Very soon he was able to rejoice his employers with about two thousand barrels of crude petroleum. New shafts were quickly sunk in every direction, and in the following year five hundred thousand barrels rewarded the lucky borers. This strike proved magical in another sense, for at once the price of crude petroleum fell from twenty-three cents per gallon to twelve cents, and that

of refined oil fell from forty-five to thirty-two cents. Very soon this was further reduced to nine cents for crude oil and nineteen for refined! Already this precious "earth-oil" asserted its privilege of being a special boon to the poor.

Of course, this news spread like wild-fire, and from far and near men came crowding to the wonderful oil-yielding region, and the land was riddled with borings varying from six hundred to sixteen hundred feet in depth, of which it was estimated that not more than one in six yielded profitable returns. Nevertheless, two years after Colonel Drake had sunk his first shaft, the oil-yield had increased to upward of two million barrels, and in the following year it reached three million! As the yield of some wells decreased, new ones were struck in other isolated spots.

Of course, fire is the danger most to be dreaded by all oil-communities. Nowhere, unless in a powder-magazine, does the chance spark carry with it such probability of doing mischief as in this gas-laden atmosphere, where everything seems to be inflammable. Sometimes through grievous negligence, but more often by the action of lightning, a tank containing perhaps three or four thousand barrels of oil is struck, and then all efforts to extinguish the flames are known to be futile—the owners can only stand afar off and watch this magnificent bonfire, which must blaze on till it has utterly consumed all that feeds it. Sometimes the gas escaping from a flowing well ignites while the oil-jet is in full play, and then grand indeed, but most awful, is the spectacle of that genuine "fire-fountain"—a column of living fire tossed far above the dark tree-tops, and falling in a beautiful but scathing rain, with a roar more deafening even than that of its ordinary condition.

Nor do the dread possibilities of fire as connected with the petroleum-trade end here. In all the pages of marine disaster, none are more terrible than those which record how on several occasions (sometimes when in harbor in the midst of crowded shipping) vessels laden with petroleum have taken fire, and their cargo has overspread the sea in a film of inextinguishable floating fire, carrying death and destruction wheresoever it penetrated. This, I think, brings us to the climax of possible horrors in connection with this subject.

The "earth-oil" is found in various parts of North America; but Pennsylvania is said to yield about seven times as much as all the others collectively. Canada has springs of her own to the north of Lake Ontario; but the great petroleum-region of the States lies partly in New York, but chiefly in Pennsylvania near the shores of Lake Erie. The oil-bearing sandstone underlies a tract of heavily timbered hill-country watered by the Alleghany River. Here the principal oil-springs have been struck in isolated patches, dotting a belt of territory which is roughly estimated at about one hundred and fifty miles in length by about thirty in maximum breadth, covering an area of less than

200,000 acres. Ohio and West Virginia also contribute something to the general oil-supply.

To whatever cause the formation of petroleum is due (and it is generally attributed to the decomposition under enormous pressure of vast deposits of animal and vegetable matter), it is now ascertained that it exists in rocks of nearly all geological ages. Upper and Lower Devonian, Silurian, and Tertiary, have all been proved to be oleiferous. One thing worthy of note is, that the springs are generally found near the base of great hills. We have already seen that those of Venezuela lie among the spurs of the Cordilleras. Those of Pennsylvania lie chiefly near the Alleghanies, and the great oil-region of the Caspian is overshadowed by the Caucasus.

In the year 1876 (seventeen years after Colonel Drake had bored his first well) it was estimated that 20,000 wells had been sunk in Pennsylvania and West Virginia at a cost of $190,000,000, the oil produced being valued at $300,000,000 at the wells—cost of carriage to the seaboard adding one fourth to the value of an oil-cargo. In 1879 the production of oil in the United States was estimated at about 15,000,000 barrels, equal to 600,000,000 gallons. In 1880 upward of 400,000,000 gallons, valued at $46,000,000, were exported from the States, irrespective of the enormous home consumption.

Very remarkable is the organization whereby an elaborate system of iron pipes connects all the wells in the most remote districts of Petrolea with enormous tanks, wherein the oil from many wells is stored, and is thence conveyed by main pipes to the nearest railway-station, where it runs into another series of great reservoirs, thence to be transferred to the locomotive tanks or oil-wagons. These are cylinders resembling great steamboat funnels laid lengthwise on the wagon. From the center of each cylinder rises a large iron cupola, constructed to allow for the expansion of the oil should it become heated. Such wagon-trains are about as dirty and greasy looking concerns as can well be imagined.

In many cases their services are dispensed with, and the main pipes —which have a diameter of from four to six inches—are carried direct to the great refineries. One of these at Cleveland is one hundred and seven miles distant from the wells which feed it; another at Buffalo is distant seventy-eight miles; and that at Pittsburg is thirty-eight miles from its source of supply. Two great main pumps are led three hundred miles to Bayonne on the seaboard of New York Bay, and there deliver their cargo ready for shipping. Pumping-engines working at intervals of twenty-five miles give an impetus to the flow of these oil-streams.

This pipe business is all in the hands of two great companies; and some idea may be formed of the vast scale on which they work, from the fact that the principal company—distinguished as "The United Pipe Lines Company"—owns three thousand miles of pipes, and

provides in its five hundred great iron tanks storage for upward of 30,000,000 barrels! The company receive all the oil yielded by the wells of certain districts, and account to the owners of each for the amount received.

The oil thus obtained is not all alike in quality. There are a few wells at Mecca in Ohio, some in Illinois, and others near Franklin in Pennsylvania, where it is of extraordinary thickness, and can be used as grease without further preparation. It fetches about five times the price of ordinary crude petroleum, and at the present moment sells at £4 per barrel. At Mecca this lubricating oil is found in an area fifteen miles in length by five in width. It is estimated that 500,000 barrels have already been taken out, by pumping wells at an average of forty feet in depth.

Passing north across Lake Erie to the "Dominion," we find four distinct oil-bearing areas. They lie in Tilsonburg, Enniskillen, Mosa, and Oxford townships. As in the States, so in Canada, the oil-region has been suggestively named Petrolea—a name, however, which applies eepecially to this principal city.

It is just about twenty years since Mr. Murray, geological surveyor, in riding through the dense untrodden forests of oak and hickory, observed here and there beds of bituminous matter, and on closer examination he became convinced that these were deposits where oil-springs had overflowed and evaporated. At a place now known as Thamesville (the counterpart of the Titusville of Pennsylvania) he perceived oil floating on a stream, and found that there, too, the people were in the habit of gathering up this scum in flannel, and using it as ointment for wounds on horses.

He called official attention to the subject, and soon the silence of the forests was a thing of the past, and the district was overrun by crowds of busy men.

Now oil cities "spring up" with mushroom speed, wherever productive springs are struck in new districts. With oil, as with all else in the States and the Dominion, there is a constant movement toward the northwest; and every one, who finds his oil-supply failing, as a matter of course moves to the northwest, taking with him his pump and derrick, and all the casing of the well, and sets up his drilling apparatus wherever the ground appears most promising.

The yield of oil is not to be compared with that of the Pennsylvania springs, and two years ago it was estimated that the sixteen hundred wells then in active operation did not collectively yield on an average more than 2,400 barrels per diem. The richest well at present is "The Lawyer," near Marthaville, which has an average flow of eighty barrels a day; but, on the other hand, many only yield one barrel. The oil here is generally a greenish-black fluid of the consistency of sirup, and is mixed with much water and some gas.

[*To be continued.*]

SKETCH OF PROFESSOR JAMES HALL.

THE name of Professor James Hall is inseparably associated with the growth of American geology, the classification of the palæozoic strata of the continent, and the systematization of their paleontology. Connected with the New York State Geological Survey since 1837, he has been for about forty years, as chief of the paleontological department, engaged in the study of fossil remains. His words are now referred to in illustration of, and his name is cited as authority on, questions connected with the older geological formations of the continent, by the geologists of the world more frequently than those, probably, of any other American in the same field.

James Hall was born, of English parents, in Hingham, Massachusetts, on the 12th of September, 1811. He studied natural history, under the direction of Amos Eaton, at the Rensselaer Polytechnic Institute in Troy, New York, where he afterward became Professor of Geology. Professor Eaton had already, by his lectures before the members of the State Legislature and other audiences, and by his instrumentality in the organization of the Troy Lyceum of Natural History and in the formation of its geological collection, contributed to awaken an interest in the study of the natural history and geology of the State. He had superintended an agricultural and geological survey of Rensselaer and Albany Counties, and had made a survey of the district adjoining the Erie Canal, and published a report upon it. The subject of instituting a complete geological survey of the State was presented before the Legislature in 1834, and the act making provision for the work was passed in 1836. In the organization of the survey the State was divided into four districts, of which Mr. Hall was appointed assistant in the second district, under Professor Ebenezer Emmons, of Williams College. The district included the counties of Warren, Essex, Clinton, Franklin, Hamilton, and St. Lawrence, and afterward Jefferson. At the end of the year, on the appointment of Mr. Conrad, of the third district, to the department of paleontology, and the transfer of Mr. Vanuxen, of the fourth district, to the position he vacated, Mr. Hall was made geologist of the third district, including the counties of Montgomery, Herkimer, Oneida, Lewis, Oswego, Madison, Onondaga, Cayuga, Wayne, Ontario, Monroe, Orleans, and Livingston. He published annual reports of his work regularly from 1838 to 1841, and concluded the series with a final report in 1843, which forms one of the series of works on the natural history of the State published by the Legislature. In this volume he gave a full description of the order and succession of the strata, their mineralogical and lithological characters, and the organic remains contained in them. Concerning the form in which the volumes of the reports are published, Professor Hall has related an incident that affords a curious

illustration of American official spread-eagleism. The incumbents of the several departments of the survey wished to publish their works in octavo, so that the results might appear in convenient form, and become hand-books for students of science. The plan was overruled by Governor Seward and his advisers, "who considered it due to the dignity and importance of the State of New York that the volumes should be published in quarto form, especially as they were to be presented to other States and foreign governments as emblematic of the greatness of the State." The survey was reorganized between 1842 and 1844. A department of agriculture was added, and the paleontological department—Mr. Conrad having resigned without making a report—was assigned to Professor Hall, who began his work in 1844, "almost without a collection of fossils of any kind, without a library for reference, without artists, or any of the appliances or resources considered necessary in scientific investigation. It became necessary to create the department from the beginning." No appropriations of money were made by the State for the collection of fossils till 1856, when provision was made for eight years, and the whole burden of labor and expense was till then thrown upon Professor Hall. He was assisted in these arduous labors by his wife, who drew the figures of a large number of the fossils.

Five volumes of the "Paleontology" have been published, two of which were divided into two parts, making seven bound volumes. As analyzed by Dr. T. Sterry Hunt, the first volume, of 338 pages and one hundred plates, contains descriptions of all the organic remains, both of animals and plants, beginning with the lowest member of the New York system and ascending to the Champlain division, which terminates in the Hudson River group, corresponding to the Cambrian of Sedgwick, or the Cambrian and Lower Silurian of Murchison. The second volume, of 362 pages and more than a hundred plates, continues the system up to the base of the Onondaga or Salina formation. The third volume, of 533 pages, with 128 plates, includes all the fossil remains of the water-limes, the Lower Helderberg, and Oriskany divisions, except the corals and bryozoa. The fourth volume includes the brachiopoda of the Upper Helderberg, Hamilton, Portage, and Chemung divisions, which together constitute the Erian or Devonian. The fifth volume contains the lamellibranchiates of the divisions just named, together with a review of all the lamellibranchiate forms of the lower formations. Two other volumes are to include the gasteropodæ, cephalopodæ, crustaceæ, crinoideæ, bryozoæ, and corals of the Erian. Professor Hall has prepared, also, for the "Paleontology," a complete revision of the brachiopods of North America, with about fifty plates, in aid of which he has extended his researches to the Rocky Mountains, tracing the great divisions of the New York series over the intervening region; and the identifications made by him have served as the basis of all our knowledge of the geology of the Mississippi Basin.

Professor Hall himself says of the *rationale* of the system of nomenclature under which the New York surveys were conducted, and which has served as the basis of the Western surveys: "Since there was no possibility of identifying the individual rocks and groups of strata with those of Europe, as described, the New York geologists were compelled to give names to the different members of the series; and since the sandstones, limestones, slates, and shales are so similar in different and successive groups, it was impossible to give descriptive names which would discriminate the one from the other. Therefore, local names were proposed and adopted; as, for example, Potsdam sandstone, Trenton limestone, Niagara limestone, and Niagara shale (the two latter, with subordinate beds, making up the Niagara group), the Medina sandstone, the Onondaga salt group, the Hamilton, Portage, and Chemung groups, thus giving typical localities of the rock instead of descriptive names. This method or system of nomenclature leaves no possibility of mistake or confusion which might arise from a different appreciation of descriptive terms. The typical locality always remains for study, comparison, and reference, and there need be no difference of opinion or discussion as to what was intended by the use of any one of the terms. The progress of geological science in the country is greatly indebted to this system of nomenclature, and to the absolute working out of the succession of the groups, and the members of the same, to which it has been applied." The system was adopted by a vote of the Geological Board.

The geologists of the survey were accustomed to meet once a year in the Capitol of the State, to compare notes. "The comparison of observations and interchange of views led to the opening of correspondence, by a formal resolution of the New York Board, with other geologists, especially with those engaged in State surveys, of which several were then in progress. This correspondence led to an agreement for a meeting of geologists in Philadelphia in the spring of 1840, and this assemblage, of less than a score of persons, led to the organization of the Association of American Geologists, which, at a later period, on the occasion of its third meeting, added the term Naturalists; and, finally, by expanding its title, it became the American Association for the Advancement of Science." Professor Hall was president of this association, under its present title, at its Albany meeting in 1856.

The general results of Professor Hall's comparative studies in the West are given in the third volume of the "Paleontology," and more fully in the first volume of the "Report on the Geology of Iowa," where he was engaged in the survey, with Whitney and Worthen. To this survey he contributed a memoir on the paleontology of the State, as he did to the survey of Wisconsin; and some of the fruits of his paleontological labors may be found embodied in the geological reports of several other States. He declined to take the direction of the

paleontological department of the survey of Canada, under Sir William Logan, but undertook the study of the graptolites of the Quebec group, and published a monograph on them, which was afterward republished, with additions, in the "Twentieth Report of the New York State Cabinet of Natural History." The list of his other contributions to American geology includes articles in the reports of the "State Cabinet and State Museum"; "Descriptions of Organic Remains," given in the Government reports of various Western surveys, including the reports of Fremont, Stansbury, and the boundary survey of the United States and Mexico; and numerous contributions to the "American Journal of Science," and to various scientific societies at home and abroad. He is a foreign member of the Geological Society of London, and received the Wollaston medal from it in 1858; and is a corresponding member of the Institute of France.

M. Ch. Barrois, reviewing in the "Revue Scientifique" the latest published volume of Professor Hall's "Paleontology," says that, like all the other publications of the author, it "brings an ample harvest of new and important facts. It would form the base and the foundation of the study of the palæozoic bivalves, if it did not have to share that honor with the work recently published by our regretted compatriot Barrande, on the 'Acephalæ of the Silurian of Bohemia.' Never will the names be separated of these two superior men, who have devoted themselves during this century with an equal activity to the study of the palæozoic faunas. Born in countries distant from each other, in environments still more widely separated in modes of thought, Barrande and James Hall came to fill the same part in the history of science. The same love of research and of the truth animated them; the same indomitable energy constantly encouraged and sustained them; and, with all the work that has been accomplished by numbers of other specialists, every one will recognize that these two men have competently described the fauna of the transition-beds. They have done more in that direction than all the rest of their generation."

Professor Hall devoted much attention to the study of crystalline as well as of fossiliferous stratified rocks, and was, according to Dr. Hunt, the first to point out the persistence and significance of mineralogical character as a guide to their classification, in the manner which has since been developed and extended by the latter geologist. Among his other most important contributions to geological science is his suggestion of a rational theory of mountains, in regarding them as the products of erosion, aided by the upheaval and contortion of strata as an incidental, not a chief factor.

The magnificent collection of fossils accumulated by Professor Hall during the course of his geological work has been transferred to the American Museum of Natural History, and now forms a part of the cabinet in the New York Central Park.

EDITOR'S TABLE.

THE AMERICAN ASSOCIATION AT PHILADELPHIA.

THE recent meeting of the American Scientific Association at Philadelphia was an eminently successful one. It was the largest ever held, the number of papers read was greater, and their merit above the past average. The presidential address by Professor Young, which we reprint, was a production of unusual ability. He chose the theme upon which he was best qualified to speak, the present state of astronomical science, with reference to its imperfectly solved problems, and the researches to which attention must next be given.

The great drawback to the enjoyment of the meeting was the intolerable heat, which was the more aggravating as there was so much to see, and so much laid out to do; but the Philadelphians, by their generous hospitality and their liberal arrangements for the pleasure and entertainment of visitors, did everything possible to mitigate the calamity of the weather.

The project of a permanent international scientific association, to which we have before called attention, was taken up and favorably received, although in the opinion of many the time has not yet come when such a plan can be vigorously carried out. It is reported that the project "has now a more assured existence" inasmuch as the philanthropist, Mrs. Elizabeth Thompson, has contributed $5,000 to it and will give $5,000 more next year, on the condition that $10,000 are furnished from other sources. This lady also donated $1,000 to the American Association to promote researches in light and heat.

The coming of the British Association in full force to Montreal to hold a meeting, to be immediately followed by the session of the American Association in Philadelphia in which many British scientists took part, has naturally raised various questions of comparison between the policy and working of the two bodies. We give some of the points of comparison and contrast.

The Canadian meeting was considerably the larger: 1,773 members were registered, of whom about one half crossed the ocean. This is below the average of the past ten years by about a hundred members. The number of members registered at Philadelphia was 1,261, or about five hundred less than at the Montreal meeting. Of these, 303 were foreign visitors.

Fewer papers were read at the American Association than at the British, but more in proportion to the membership, 304 being reported at Philadelphia, and 327 at Montreal. But some forty, or one eighth of the entire number, were contributed by American gentlemen attending the Canada meeting. The character of the work at both meetings is generally admitted to be above the average. Of the five papers recommended by the British Association to be published in full, two were from the States; one by Professor Gray, and one by Professor Thurston.

Both Associations adopt the plan of appointing special committees to investigate and report upon designated subjects; but the British Association carries it out much more thoroughly than the American. While the reports at the Philadelphia meeting were so meager that "it can be hardly said there were any," on the other hand, "in addition to the regular papers, there were in the various sections of the British Association more than fifty reports presented, coming from committees ap-

pointed at previous meetings." This is at least partly accounted for by the fact that the British Association makes grants of money to its committees to remunerate for services, no less than $7,500 being thus allowed at the Montreal meeting, while our own Association makes no such allowances.

Upon bringing English and American scientific work into the closer comparison which this new experience allows, the superiority, it must be confessed, belongs to the older and larger body. A writer in "Science," after contrasting various features of the two organizations, justly remarks: "On the whole, it will be admitted that the British Association does its work upon a higher plane than that occupied by the American. Its sectional work shows more that is really new and of lasting value, and less that is trifling; although there has been a steady and healthful improvement in the character of the American Association during several years past. It may be well to remark here that there are at least a few of the ablest and best men in American science who have continued to exhibit no interest in the American Association; and that, if the Association is not precisely what they believe it ought to be, the fault lies at their own doors. No others should or could be so influential in shaping its course and molding its character."

HARRISON, COMTE, AND SPENCER.

Upward of twenty years ago, when Mr. Herbert Spencer first began to publish the system of thought upon which he has since been occupied, he was charged with being a disciple of Comte, and indebted to him for his cardinal ideas. The reply made by Mr. Spencer at the time was generally held to be so effectual that but little more was heard of the matter. But some of the more ardent followers of Comte refused to be convinced, and among them is Mr. Frederic Harrison, who has now revived the accusation, and stoutly maintains that, if not directly, then indirectly, Spencer owes his main and most characteristic conceptions to Comte.

It has been well understood that Mr. Frederic Harrison is the leading English representative of the Positive philosophy, though, like Mill, he has been credited with a good deal of independence and reservation in the acceptance of the Positivist system. But his address on September 5th before the members of the Positivist Society at Newton Hall, in London, where he preaches, shows a servility of discipleship for which we were quite unprepared. The subject of the discourse was "The Memory of Auguste Comte and his True Work," the occasion being the anniversary of the death of that philosopher. It was, of course, to be expected that Mr. Harrison would not let such an opportunity pass without speaking in high terms of the genius of Comte and the importance of his labors; but the performance is quite startling from its lurid eulogy and the wild extravagance of its claims in regard to Comte's character and mission. He credits him substantially with all the greatest steps of advance in science, philosophy, and religion that have been made in the present century. Comte's classification of the sciences is pronounced to be final. Though a phrenologist, and openly repudiating modern psychology, Mr. Harrison insists that Comte has made the most important step of the century in psychology. The idea that law rules in the moral and social as well as in the physical sphere belongs to Comte. He instituted the science of sociology, and constituted it in all its material parts. And, among his other accomplishments, this wonderful Frenchman challenges the admiration and gratitude of the world as the founder of a new religion.

These undiscriminating and inordi-

nate claims leave little room, of course, for the recognition of the merits of other men; all who came since are but followers and imitators of Comte. It was supposed that Mr. Spencer had done some important original work in philosophy, psychology, and sociology, but Mr. Frederic Harrison says he has given the world nothing "but a very unsuccessful attempt to re-edit Comte's work on a plan of his own."

Such a charge as this could not assuredly be suffered to pass; and it is well that it was thus sweepingly made while Mr. Spencer is living and able to deal with it. The publication of Harrison's address opened a controversy at once in the leading London newspapers. We have room for only a part of it, and we select the most important part. We reprint two letters by Mr. Spencer, which are of interest as throwing light upon the true origin of his system. It will not be denied that Mr. Spencer knows more about it than anybody else; and when attacked by this imputation of wholesale plagiarism, the alternative of incompetence to judge where his leading conceptions came from, it is desirable to know what he has to say, both as a question of the history of thought and as a matter of justice to himself. We have a vast apparatus of legislatures and courts to secure to men their material possessions; but, when it comes to property in ideas, nothing remains for thinkers but to lose it or to defend it themselves.

IS THE CONTRAST VALID?

President Porter, of Yale, has lately made answer, in the "Princeton Review," to the argument of President Eliot, of Harvard, in the "Century," entitled "What is a Liberal Education?" At the close of his paper, Dr. Porter refers to the Appendix to the third edition of "A College Fetich," in which Mr. Adams has included the chief portion of the paper of Professor James on "The Classical Question in Germany," and some other matter from "The Popular Science Monthly."

We are glad to observe that Dr. Porter admits the essential justice of Professor James's case. The "Berlin Report" had been translated and widely circulated to show that, by long and extensive German experience in the trial of two school systems, it was settled that classical education is superior to scientific education; and that this was admitted even by the most eminent scientific men. Professor James proved that the "Report" settles no such question, and Dr. Porter so far acknowledges this as to say, "It may certainly be conceded to the critic that the 'practical trial' of the two systems of study—the classical and the non- or less classical—was not in all respects fair or decisive." If Dr. Porter had said it was not in *any* respect fair or decisive, we believe he would have been still nearer the truth.

But we are just now more concerned with another point of his statement in relation to the validity of the contrast, for important educational purposes, between the study of words and the study of things. Dr. Porter refers to this matter as follows:

> The long extracts from Professor E. L. Youmans, taken from "The Popular Science Monthly," are significant as urging the point made by President Eliot, that classical is essentially inferior to scientific culture because "it trains the verbal memory and the reason so far as it is exercised in transposing thought from one form of expression to another, . . . while the new method cultivates the powers of observation and the faculty of reasoning upon the objects of experience so as to educate the judgment upon the problems of life. . . . The problems of life, as we understand them, are to a very large extent those which concern human relations, and these are quite as important as those which are commonly called facts or phenomena. To a large extent they are not material relations, and are not subjects of sensible experiment or verification. The facts and the reasoning must also be stated in language clearly, forcibly, and convincingly, in order to convince the

reason and affect the conduct. To interpret and employ language, even with those who think themselves employed about facts, is consequently one of the chief occupations of all those who have power with their fellow-men, whether their sphere of thought is material or spiritual 'things.' The pretended contrast between thought and words is not valid, especially when used for so sweeping an induction as that made by Professors Cooke and Youmans or President Eliot."

The contrast between words and things is certainly not a pretense but a reality; and we are unable to see how the validity of the induction in this case is in any way dependent upon the sweep of its application. It is claimed by nobody in this controversy that words are unimportant or that language-studies are not of great value; but it is maintained that the things represented are more important than their signs, and Nature-studies of higher value than lingual studies, and the whole issue turns upon the recognition of this fact. Historically, this contrast has been proved to be profound and momentous. In the pre-scientific ages, words were not only put in the place of things, but confounded with them so as to vitiate whole systems of thought as shown in the history of Greek speculation and the scholasticism of the middle ages. The investigation of truth was made to consist in mere verbal manipulations. The Baconian reform in philosophy consisted in demanding that the human mind shall no longer occupy itself in the verbal sphere, but shall break through the barriers of words and study the things they represent. The inductive philosophy began with facts—the observation and investigation of things—and was a new method which has revolutionized knowledge, created the modern sciences, and revealed the order of Nature. It is contrasted with verbal and literary studies, which accept common notions—the loose, vague, crude ideas of ordinary experience—and can not advance and perfect knowledge because it refuses to make facts first and to exercise the mind in their close and careful study. Is a contrast so broad as this, between a fruitless method which kept the mind stationary for centuries and a method so fruitful as to give origin to a vast body of accurate and productive truth, to be regarded as a pretense when it is claimed to be fundamental in education? The verbal system is historic, traditional, popular, and all-prevalent in our systems of mental cultivation. It is proposed by the reformers not to destroy it, but to reduce its exaggerated proportions, and give greater prominence to the systematic study of actual things. The demand is that there shall be a new discipline in education, begun early and pursued thoroughly, by the mastery of given branches of science at first hand. The contrast between words and things must be at any rate held valid for the accomplishment of this reasonable object. That this claim is a moderate and sober one, and has long been firmly held by educators of the highest character, might be shown by quotations from many authorities; Dr. William Whewell thus remarks upon it:

Of the mode in which this culture of the inductive habit of mind, or at least appreciation of the method and its results, is to be promoted—if I might presume to give an opinion—I should say that one obvious mode of effecting this discipline of the mind in induction is, the exact and solid study of some portion of inductive knowledge. I do not mean the mechanical sciences alone, physical astronomy and the like, though these undoubtedly have a prerogative value as the instruments of such a culture; but the like effect will be promoted by the exact and solid study of any portion of the circle of natural sciences; botany, comparative anatomy, geology, chemistry, for instance. But I say the *exact* and *solid* knowledge; not a mere verbal knowledge, but a knowledge which is real in its character, though it may be elementary and limited in its extent. The knowledge of which I speak must be a knowledge of things, and not merely of names of things; an acquaintance with the operations and productions of Nature, as they appear to the eye, not merely an acquaintance with what has

been said about them; a knowledge of the laws of Nature seen in special experiments and observations, before they are conceived in general terms; a knowledge of the types of natural forms, gathered from individual cases already made familiar. By such study of one or more departments of inductive knowledge, the mind may escape from the thralldom and illusion which reign in the world of mere words.

LITERARY NOTICES.

A Naturalist's Rambles about Home. By Charles C. Abbott. New York: D. Appleton & Co. Pp. 485. Price, $1.50.

There is no denying that natural history is one of the most fascinating of subjects, and now and then there appears a book written by some enthusiastic lover of nature, who has entered into communion with the inferior animate creatures, and writes a living book so pleasing and attractive that it is sought by readers with the avidity of a romance. Such works are never compilations, never scientific treatises, in the usual sense, but always original in observation, full of instruction, life-like and agreeable in description, and abounding in sympathetic interest with the habits, peculiarities, and curious lives of that portion of the animal kingdom which is taken up.

Mr. Abbott's book belongs to this class. Its author is a working naturalist who has made animal life a systematic and scientific study, of course with the aid of books, museums, and the usual helps, but he has always been fond of making the acquaintance of all the animals within reach, watching their ways, noting their characteristics, clearing up obscurities in their history, and finding out everything he could of interest concerning them. He has been an out-of-door student, at home with all sorts of mammals, birds, reptiles, and fishes that he could find in his neighborhood excursions, and the present book is a charming record of his varied observations, investigations, experiences, and adventures in his natural history excursions about home for many years.

We have often thought of that wealth of the farmer owning one or two hundred acres of land, which he never inventories when making up a statement of his property. It is wealth which he can not sell, but does not have to buy, and he can only know of its existence or appreciate its magnitude in proportion to his intelligence regarding natural things. The soil of his hundred acres is a chemical laboratory in which he operates upon hundreds of thousands of tons of materials to carry on the most exquisite and multifarious chemical changes. Mineralogy and geology explain the depths of his estate. He may be said to own the atmosphere as far up as it extends above his grounds, with its millions of tons of gases, and if he is familiar with Sir William Thomson's paper on "The Energy of a Cubic Mile of Sunlight," he can understand the enormous amount of solar power which is necessary to drive the organic operations of his farm, and of which he may regard himself as the proprietor. Then there is a little world of vegetable life, of which he is the intellectual owner, if he knows something of botany, while his streams and ponds and earth abound with animal forms, besides the endless insect-life, the animals of field and forest, and the birds of the air, which are in a high sense his if he has enough of zoölogy to understand them. The lesson of the situation is, that there is an inexhaustible wealth and world of wonders about home to the mind so cultivated that it can discover and appreciate them.

Mr. Abbott has limited the scope of his natural history observations to his home environment, and he accordingly offers us "A Word at the Start, in Lieu of Preface," in which he describes his location and gives some clews to its interest for natural history purposes. He lives in "the Jerseys," on Crosswicks Creek, a navigable stream that enters the Delaware River at Bordentown. His ancestor came from Nottingham two hundred years ago, and he now lives in a house built by his great-grandfather on the edge of a high terrace, and surrounded by old oaks, beeches, and locusts, under which the author declares that he chiefly lives. There is nothing romantic in the neighborhood, but it has long been a center of special interest to students of natural history. It has been much visited by botanists and zoölogists—Bertram, the poet and naturalist; Conrad the elder, botanist and mineralogist; Conrad the geologist, his son; and Rafinesque, Say, Le Seure, Bona-

parte, Wilson, and other celebrities, visited the location; and the names of some, cut by themselves in the bark of one of the old beeches that guards a famous spring, are still to be deciphered. Such is the neighborhood which Mr. Abbott has explored for its natural history resources, and the results of which are described in these "Rambles about Home." His book is most entertaining. It is written in a simple, unaffected, and entirely untechnical style, and the reader becomes at once interested wherever he dips into the book. Mr. Abbott writes constantly of what he has himself seen, and he has been a painstaking and indefatigable searcher of all kinds of curious and interesting things in the life-history of the beasts, birds, fishes, and reptiles which belong to his immediate region. It is unnecessary to give illustrations here of his way of working, as we have already quoted from his teeming pages in the August "Monthly"; but we cordially recommend the volume to those in search of useful and agreeable reading as one of the pleasantest books of the season.

The Discoveries of America to the Year 1525. By Arthur James Weise. New York: G. P. Putnam's Sons. Pp. 380, with Maps. Price, $4.50.

This book bears the marks of industrious research in fields that have not yet been overworked, and which offer irresistible allurements to the historical inquirer. Starting with the assertion that "America in the early ages was one of the inhabited parts of the earth," the author accepts as historical the story of Atlantis, which is said by Plato to have been told by the Egyptian priests to Solon, and repeats it, while he finds confirmation of a part, at least, of its incidents in the biblical account of the first men. He discredits the relations of the discoveries of America by the Northmen as resting "more upon conjecture than evidence." Then, reviewing briefly the stories of the voyage of the Welsh Madoc and of the discoveries of the Zeni brothers, and the travels of Marco Polo and Sir John de Mandeville, he finds himself at last upon safer ground in treating the history of the voyages of the early Portuguese navigators, and Columbus, and of those who followed them. The whole is enriched with copious citations from the mass of literature on the subject, ancient and modern, much of which is rare. On this point the author remarks that the writing of his work "required the personal examination of many old and rare books, manuscripts, and maps, besides the perusal of a large number of recent papers and publications relating to its subject. The task further demanded a careful review and comparison of the various statements of historical writers concerning the voyages of the persons whom they believed to have been the discoverers of certain parts of America. . . . It seemed to me that some of the information contained in the different works which I had examined should be presented in the language of the writers, or in faithful translations, so that the intended significance of the information could be perceived by the reader." Thus, by its matter, and the way in which it is presented, the work is one of great value and unusual interest.

Samuel Adams, the Man of the Town-Meeting. By James K. Hosmer. Baltimore: N. Murray. Pp. 60. Price, 35 cents.

This sketch, which is based on studies for a new life of Samuel Adams, is one of the "Johns Hopkins University Studies" in Historical and Political Science. Its aim is, first, to present a life-like picture of the New England town-meeting in its purest state as illustrated in the meetings of Boston town in colonial times; and, second, to exhibit Samuel Adams as the conspicuous leader of the town-meeting, and as one of the ablest as well as one of the purest managers of men in our history. The tracing of Adams's work in the under-currents of politics is very clear; and from it he appears as a principal though not always an open director of the movements, in the South as well as in the North, that resulted in the Revolution.

On the Nature of Light. By George G. Stokes, M. A., F. R. S., etc. London: Macmillan & Co. Pp. 133. Price, 75 cents.

Professor Stokes, having been appointed to deliver three annual courses of lectures, on the endowment of John Burnett, of Aberdeen, chose "Light" as his general subject, and devoted the four lectures of the first course to a discussion of the nature of

light. These discourses, which constitute the present volume, were delivered in November, 1883. In the first, the emission and the undulation theories of light are stated, and the insufficiency of the former is shown. Explanations of the phenomena of interference and diffraction by means of the undulation theory follow, and, in the third and fourth lectures, double refraction, polarization, and the interference of polarized light are considered.

Chemistry: General, Medical, and Pharmaceutical, including the Chemistry of the United States Pharmacopœia. By John Attfield, F. R. S. Tenth edition, specially revised by the author for America. Philadelphia: Henry C. Lea's Son & Co. Pp. 727.

This compact volume is, first of all, a text-book of general chemistry, in which the substances and processes used in medical and pharmaceutical chemistry have been employed in illustrating the principles of the science. "From other chemical text-books," says the author in his preface, "it differs in three particulars: first, in the exclusion of matter relating to compounds, which at present are only of interest to the scientific chemist; secondly, in containing more or less of the chemistry of every substance recognized officially or in general practice as a remedial agent; thirdly, in the paragraphs being so cast that the volume may be used as a guide in studying the science experimentally." The book contains also directions and tables for qualitative and quantitative analyses, and in these departments, likewise, special prominence is given to substances used as drugs. Naturally, organic compounds receive more attention than in the ordinary text-book on general chemistry, and a large amount of information, valuable to the physician and the pharmacist, is distributed through the volume.

Electricity, Magnetism, and Electric Telegraphy. By Thomas D. Lockwood. New York: D. Van Nostrand. Pp. 377. Price, $2.50.

Telegraph and telephone operators, line-men, and others connected in similar capacities with the applications of electricity, have generally had scanty opportunities for education, and seldom possess a sufficient understanding of electrical science to enable them to attain important and lucrative positions. It is especially for this class that the present book is written, though it is equally available for the general reader who wishes to understand the construction and operation of the electrical appliances which he sees in use. The text is arranged in the form of question and answer, the answers varying from a few lines to a couple of pages in length, and is illustrated with 152 cuts. Frictional and voltaic electricity, thermo-electricity, and magnetism, are taken up in successive chapters, questions about dynamo-electric machines are then answered, and two chapters are devoted to methods of electrical measurements, and to the terms and units used. The next eight chapters are devoted to telegraphy, beginning with the principles as exemplified in different systems, and including such subjects as line-construction and the adjustment and care of telegraph-instruments. Electric lighting, electro-metallurgy, electric bells, electro-therapeutics, and the telephone, are dealt with in single chapters, and a number of minor applications receive brief mention. Tables showing the weight and electrical resistance of various qualities of wire and other tables are appended.

The Principles of Ventilation and Heating, and their Practical Application. By John S. Billings, M. D., LL. D., Surgeon U. S. Army. New York: "The Sanitary Engineer." Pp. 214. Price, $3.

This book contains the substance of a series of articles originally published in "The Sanitary Engineer," with some new matter. It is intended to present the general principles which should guide a person in judging of various systems of, and appliances for, ventilation. Dr. Billings insists on the inseparable connection between ventilation and heating, and lays down as his first axiom, which applies especially to the large cities in our Northern States, that "in this climate it is impossible to have at the same time good ventilation, sufficient heating, and cheapness." After some preliminary considerations of heat and gases, the author takes up methods of heating, patent systems of ventilation and heating, means for removing dust and for supply-

ing moisture, and chimneys. Chapters are devoted to the ventilation of halls of audience, theatres, schools, and hospitals, and to ventilation by aspiration. The volume is illustrated by seventy-two plates and diagrams.

Natural Law in the Spiritual World. By Henry Drummond, F. R. S. E., F. G. S. New York: James Pott & Co. Pp. 414. Price, $1.50.

This interesting book is directed to the problem of the relations of religion and science, and presents a new view from an advanced stand-point, which many regard as helpful and healthful in its influence. It is not to be denied that the author's purpose is an exalted one, nor that he deals with his subject in an independent and original way, and with skill and power. His object is the essential harmony of science and religion, and his method is to show that the system of law which is established in the natural world holds equally true in the spiritual world. The work is eminently liberal, not so much from any peculiarity of the author's religious opinions, as from his fundamental position that the natural world is to be studied first, and its laws worked out as scientific verities, and that this scheme of order is to be rediscovered in the spiritual world as a part of the universal system. The position taken is not that of Horace Bushnell, who describes the spiritual world as "another system of nature incommunicably separate from ours"; and further says, "God has, in fact, erected another and higher system, that of spiritual being and government, for which Nature exists, a system not under the law of cause and effect, but ruled and marshaled under other kinds of laws." After referring to the argument as presented with acknowledged ability by Mr. Murphy in "The Scientific Basis of Faith," and to the reasoning of Butler's "Analogy," Mr. Drummond remarks: "After all, then, the spiritual world as it appears at this moment is outside of natural law. Theology continues to be considered, as it has always been, a thing apart. It remains still a stupendous and splendid construction, but on lines altogether its own." It is therefore the ambition of the author to show that the natural and spiritual worlds are constructed upon the same system, so that to the degree in which we understand the method of Nature shall we be prepared to understand the method of the spiritual world. By the implications of the argument, our first concern is with science, which elucidates natural truth; and as this is a gradual process, one science after another having slowly appeared in a necessary order of succession and preparation, the higher following the lower, so theology, the master-science, and to which all others are finally tributary, is to be developed by extending and establishing the natural laws in the spiritual sphere. It is a great thesis that Mr. Drummond has undertaken to illustrate and sustain, but he brings to the task a very able command of the results of modern science, an earnest and catholic spirit, and a reverent regard for the interests of truth, whatever forms they take. As a book of reconciliations, the volume is one of the best of its class.

Forestry in Norway: with Notices of the Physical Geography of the Country. By John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 227.

The series of Dr. Brown's books on forestry has already become quite a library (we find twelve volumes catalogued in the list prefixed to the present number), and bids fair to present all that is most important in the literature of the subject and in the experience bearing upon it. The present volume relates to a country in which the conditions are most favorable to forest-culture, and to the restoration of the woods as they are cut down. Yet the reports show that abundance has led to waste, and that, notwithstanding the great recuperative power of the Norwegian forests, they are becoming impoverished under the excessive drain that is made upon them. The greater part of the book is occupied with descriptions of the general and special features, geographical, topographical, and climatological, of Norway, and their influence upon the distribution and growth of the forests. The last chapter, on "Remedial Measures," gives account of the experimental plantations at Aas, the purchase by the Government of estates on forest-lands, and the allotment, in their several districts, of the forest officers of the government staff.

The New Physics. A Manual of Experimental Study for High Schools and Preparatory Schools for College. By John Trowbridge, Professor of Physics, Harvard University. New York: D. Appleton & Co. Pp. 367. Price, $1.50.

We have especial pleasure in calling the attention of science-teachers in our higher grades of schools to this timely and valuable text-book. Its title, "The New Physics," is appropriate in a double sense, and is, in fact, the true key to the understanding of its character and claims.

But at the outset let us say that Professor Trowbridge's book is *not* new in the sense of treating of all the latest scientific novelties. It is not a digest of information on physical subjects for instructive reading and convenient reference, and makes no account of "the latest things" which it is often thought desirable to get into school-books, to "bring them up to the present time."

But the work is new, in the first place, as representing a great step of advancement in the fundamental ideas and general view of the subject, which is now properly designated "the new physics." No one discovery in the whole sphere of scientific thought has ever proved to be so profound and far-reaching in its influence as what Dr. Faraday calls "the highest law in physical science"—the law of the conservation of energy. The older views of the nature and laws of forces—the radical problem in physics—have been left behind us, antiquated by the emergence of the great principle of correlation and conservation which gives us a new and grander conception of the method of Nature. Professor Trowbridge has first made this principle basal in the study of elementary physics, and has chosen a title for his book which marks the present advance of the subject, and sharply contrasts his treatment of it with that of the older expositions.

In the second place, the method of teaching adopted is new in the sense that it is a progressive step in total contrast with the old and still prevailing method. This book is a guide to the study of phenomena. The pupil is taken through a systematic course of experiment in the laboratory, doing his own observing, his own manipulating, and his own thinking, and thus making his acquisitions real. The literary method of studying science is entirely discarded, with its vague results and all the possibilities of coaching and cram. The pupil goes to work at the threshold, and with the assistance and direction of competent teachers, which it is assumed he will have, he carves his way, and becomes thoroughly grounded in the facts and principles of the subject. "The New Physics" thus conforms to the spirit and embodies the method of "the new education."

Physics can not be truly taught without a laboratory any more than chemistry; but the apparatus necessary is not very expensive. On this point Professor Trowbridge says:

> An elementary laboratory of physics for a school, with experiments properly selected—for it is not necessary to cover the whole ground of experimental physics in order to gain a large amount of intellectual discipline—need not cost more than a chemical laboratory such as is now provided in many high schools. I have endeavored to describe only simple and inexpensive apparatus. The teacher can readily invent simple contrivances which, in many cases, will be better than those I have recommended. My endeavor has been to point out the way to a more rational method of studying physics. In the Appendix will be found additional directions for constructing simple apparatus. It is not supposed that the student will perform all the experiments in this treatise during the time that can be devoted to physics in the secondary schools. The choice of experiments by the teacher must necessarily depend upon the apparatus on hand, which can be modified for the purpose of this treatise, and upon the amount of appropriation which can be devoted to cheap apparatus.

It is frequently said that experimenting is more play than work, and that boys like it because it is easy. But this remark is not true of Professor Trowbridge's method of studying physics, in which, with regular manipulation, close thinking is enforced. This object is to secure that kind and measure of mental discipline which the study of physical science is capable of conferring; and that implies concentrated mental exercise upon actual laboratory processes, so as to arrive at accurate results. Of course, mathematics, the language of exactness, is indispensable, and is constantly used—arithmetic, algebra, geometry. But the amount of the latter needed to use the work is very moderate. Familiarity with simple equations and an elementary knowledge of square root are required, and, as explained by the author, as much trigonometry as can be got

almost at a single sitting. But these powerful instruments of precision in mental work are absolutely necessary if physics is to be taught for the purpose of mental training.

Professor Trowbridge aims to raise the standard in the elementary study of physical science, and to make its acquisitions of permanent value. He introduces nothing that can ever have to be unlearned. He has selected for experimental and mathematical demonstration the fundamental truths in the several branches of the science of physics, which must endure, however great the future advances may be. If the student masters the treatise, he has a solid foundation upon which all future advances must be based. He has omitted all that can not be considered as fundamental; and any laboratory manual which may be published in the future must include the principal experiments of this text-book.

Its appearance at this time is especially opportune, as it meets something like an emergency in the higher education. It is designed for the use of high schools, and also "preparatory schools for college," and there is just now a vigorous effort to raise the standard of science-study in the period of preparation for college. Here Greek and Latin have had almost exclusive attention, but there is a growing demand for a better pre-collegiate grounding in science. "The New Physics," if properly used, will insure this result. It will give a more valuable discipline than the dead languages; and, while there will be as much hard work as in the grinding of Greek, it will not be repulsive work. By enlisting the active as well as the reflective powers there will be a greater variety of interest in the exercises, so that the course of the student, though arduous, will be pleasurable. It is a fallacy to make disgust at painful study an evidence of its disciplinary value; and one of the great advantages which we may expect from the broader and more liberal pursuit of science-studies in the future will be to make education more attractive than it has been in the past.

Hand-Book of the Dominion of Canada. By S. E. Dawson. Montreal: Dawson Brothers. Pp. 335, with Pocket Map.

The "Hand-Book" was prepared for the meeting of the British Association at Montreal, and therefore devotes more attention than is usual in guide-books to the scientific aspects of the country and its economical prospects. Opening with a general account of the Dominion, its physical features, statistics, enterprises of all kinds, and the condition of science, literature, and art within it, it devotes the sections that follow to more full and detailed accounts of Nova Scotia, Prince Edward Island, New Brunswick, Quebec, the lower St. Lawrence, the Labrador coast, Ontario, Manitoba, and British Columbia. A geological map of Montreal and its environs is given, in connection with a chapter on that subject.

Excessive Saving a Cause of Commercial Distress. By Uriel H. Crocker. Boston: W. B. Clarke & Carruth. Pp. 40. Price, 50 cents.

The author of this monograph, which he characterizes as "a series of assaults upon accepted principles of political economy," is a prophet whose efforts have not been appreciated by the press. He is so unfortunate as to hold views contrary to the fashionable ones, and which, consequently, whether they be well founded or not, can not be admitted to the best places in the paper. The substance of these views is, that if the public refuse to buy goods that are in the market or are making for it, dealers and manufacturers who are dependent on the sale of them must suffer distress which will eventually overtake the whole community. A few of the essays he has written in support of this theory have been published; others have been declined or sent to the waste-basket. All are given in this volume.

Electrical Appliances of the Present Day. By Major D. P. Heap, U. S. A. New York: D. Van Nostrand. Pp. 287, with Plates.

Major Heap was sent out by the Secretary of War to visit the Electrical Exhibition in Paris in 1881, and collect such information respecting it as would be of interest and value. The exhibition was complete in nearly every detail except in the application of electricity to torpedoes, concerning which the inventors of every nation preferred to keep their own secrets from those of other nations. It was par-

ticularly remarkable for the number and variety of machines for generating electricity and for the appliances used in electric lighting, and these two subjects are treated in considerable detail. In some cases a slight history of antecedent inventions is prefixed to the description of objects exhibited, to show more clearly the progress and improvement made.

The Fallacies in "Progress and Poverty," etc. By William Hanson. New York: Fowler & Wells Company. Pp. 191. Price, $1.

Besides taking issue with Mr. George on some of the points in "Progress and Poverty" and "Social Problems," the author criticises Henry Dunning Macleod's "Economics" and adds chapters of his own on the "Ethics of Protection and Free Trade" and the "Industrial Problem considered *a priori*." Mr. Hanson is as radical as Mr. George, but differs from him in particular features of his views, especially as they bear on "the Law of Rent" and "Interest"; that is, Mr. George is too conservative for him. He appears to suggest a solution of all difficulties in the acceptance of Christian principles as he interprets them.

Cholera, and its Preventive and Curative Treatment. By D. N. Rây. New York: A. L. Chatterton Publishing Company. Pp. 128.

The author of this treatise is a native, high-caste Indian, of English and American education, and is connected with the Dispensary of the Homœopathic Medical College in this city. He began to collect the material for his work in his native land, where he had the disease under constant observation. In his essay, in which he aims to group all the facts known respecting cholera, he considers the history of the disease, its etiology, modes of propagation, predisposing circumstances, the exciting causes, symptoms, complications, and sequelæ, and other accompanying features, the method of treatment, and the diet of the patient. Eight theories that have been brought forward to account for the origin of cholera are reviewed in the chapter on diagnosis. The treatment recommended is according to homœopathic principles.

On a New Method of recording the Motions of the Soft Palate. By Harrison Allen, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 34.

A new apparatus and its application are described in this volume, by which great delicacy is secured in transcribing the different motions, some of them extremely minute, of which the soft palate is susceptible. By it are recorded the changes that take place in the acts of swallowing, exhaling, coughing, hawking, sniffling, etc., and in articulation, even to the differences between the long and short sounds of the vowels. Dr. Allen suggests that his apparatus may have even a wider range of application than is delineated here, and that it may be made available for the comparative study of language, for the instruction of the deaf, and for the formation of a system of short-hand writing.

The Formation of Poisons by Micro-organisms. A Biological Study of the Germ Theory of Disease. By G. V. Black, M. D., D. D. S. Philadelphia: P. Blakiston, Son & Co. Pp. 178. Price, $1.50.

This volume contains a series of lectures which were delivered before the students of the Chicago College of Dental Surgery, and is divided into two parts. The first part embodies a review of the history and growth of the germ theory of disease, and is subsidiary to the second part, which is given, the author says, because he had "something to say that I thought ought to be said at the present time." The purpose of this "something to say" is to suggest a theory of the manner in which the germs act in producing disease. It is that, through the power which the bacteria possess in the remoleculization of matter, they cause the formation and diffusion through the system of organic alkalies having poisonous qualities comparable with those of strychnine.

The Orchids of New England: A Popular Monograph. By Henry Baldwin. New York: John Wiley & Sons. Pp. 158, with Plates.

The variety and strange beauty of the tropical orchids, so much sought for for greenhouses, give to the family a rare popular interest; and the effort to make our people acquainted with the other members of

the family growing around them, many of which are so unobtrusive in color that they might escape notice unless attention were specially called to them, is to be in every way commended. According to Mr. Baldwin, the section of the United States lying east of the Mississippi and north of North Carolina and Tennessee produces fifty-nine species and varieties of orchids, of which forty-seven are found growing in New England. The matter of the present volume is adapted to satisfy both the general reader and the inquirer for exact facts and scientific details. First, we have Mr. Baldwin's general account, free from technical terms, of the family characteristics; then, the technical synopsis of the family in New England, from Gray's "Manual." This is followed by a popular essay of living interest on the different species, from which the element of gossip is not absent, and which, adorned with many graceful woodcut illustrations, forms the bulk of the volume. At the end are given a comparative list showing the range of each species, a bibliography, and a list of students of orchids in each New England State.

Taxation in the United States, 1789–1816. By Henry Carter Adams. Pp. 79. Price, 50 cents. Institutional Beginnings in a Western State. By Jesse Macy. Pp. 38. Price, 25 cents. Indian Money as a Factor in New England Civilization. By William B. Weeden, A. M. Baltimore: N. Murray. Pp. 51. Price, 50 cents.

The monographs named above are three numbers of the "Johns Hopkins University Studies of Historical and Political Science." The subject of the first work on the list is of more than usual current interest on account of its relation to the policy of so-called "protection" which still holds its grip on our national financial polity. The first measures of taxation to which the term "protective" may be applied appear from it to have been adopted when our government had hardly yet got under way, as a foil to the efforts of Great Britain to restrict our trade and prevent the growth of American commerce, and were wholly political in their aim. The beginning of systematic efforts to build up American manufactures through the operation of the tariff was of several years later date.

The second work traces the development of social and political institutions in Iowa during the period when the communities scattered over its soil were unorganized and not attached to any kind of government. The people met, voluntarily, within their own precincts and adopted such regulations as their circumstances demanded for the protection of their lives and property, and particularly for security in the possession and confirmation of their "claims." These proceedings were outside of all law, and in fact contrary to the laws of the United States relating to the public lands, but they created a custom "whose broad and beaten path leading directly across the statute obliterated every apparent vestige of its existence"; and from the foundations laid by them has been built up the present enlightened Commonwealth.

Mr. Weeden's essay gives new and enlarged ideas of the importance of wampum as a medium of trade in the early days of the colonies, and assigns it a place among real moneys having a solid value even when estimated by the criterion by which we are accustomed to judge the gold and silver currencies of commercial nations. From this aspect of the subject the author is led to consider the relations of the two civilizations which met on our continent nearly three centuries ago, and to show that the conflicts which arose and prevailed between the whites and the Indians were not the fruits of personal hostilities, and were not dependent on ambitions or caprice, but were the inevitable results of the diverse ways of looking upon life and its duties, and of the different religious systems, to which the two parties had been bred.

Hand-Book for Horsewomen. By H. L. de Bussigny. New York: D. Appleton & Co. Pp. 75. Price, 50 cents.

A plain, practical book for teaching women to obtain and maintain a seat on the horse and to manage the animal. While advising that the English method of letting the horse to a large extent control his own movements be not neglected, it devotes particular attention to the inculcation, in addition to that, of the Continental method of bringing the animal under complete control by securing the mastery of his hind-legs.

Recognizing that woman's seat on the horse is less secure and less convenient than man's, it assumes that she will encounter more difficulties in management, and therefore stands more in need of instruction, and of a different kind.

"CATHOLIC;" AN ESSENTIAL AND EXCLUSIVE ATTRIBUTE OF THE TRUE CHURCH. By Right Reverend Monsignor CAPEL, D. D. New York: Wilcox & O'Donnell Company, and D. & J. Sadlier. Pp. 150. Price, 30 cents.

THE author, an eminent English clergyman of the Roman Catholic Church, observed during his recent visit to this country that the Protestant Episcopal Church claimed to represent the Church Catholic here, as does also the Church of England in Great Britain. Believing that the title Catholic Church or Universal is exclusive and attaches of right to his own communion only, he has prepared the little work before us, "to try and establish who is the lawful possessor" of it. This he assumes to do in a spirit, not of controversy, but of "calm, honest investigation," drawing his arguments and illustrations from standard ecclesiastical authorities and history. To these he has added papers (in the version of the Oxford translations) bearing on the subject by St. Cyprian, St. Cyril of Jerusalem, and St. Pacien, Bishop of Barcelona, all of the third and fourth centuries, and from Lord Macaulay, of the present century.

MANUAL OF BIBLICAL GEOGRAPHY: A Text-Book of Bible History. By Rev. J. L. HURLBUT, D. D.; with an Introduction by Rev. J. H. VINCENT, D. D. Chicago: Rand, McNally & Co. (Continental Publishing Company.) Pp. 158. Price, $4.50.

THE gentlemen whose names are associated on this book are well known for their activity in the "Chautauqua" assembly and circles and in Sunday-school work. The book is designed for the use of students and teachers of the Bible and for Sunday-school instruction, to furnish a complete synopsis of Biblical and parallel contemporaneous history and of the geography of "Bible lands" at all periods, from the earliest down to apostolic times. In both plan and execution it is admirably adapted to its purpose. In clear maps, of quarto size, with pictures where they will help, and associated descriptive text in which the results of modern research are incorporated, it presents all the essential facts with reference to the countries, their physical constitution and topographical features, settlements, kingdoms, boundary and dynastic changes, migrations, and the journeys of leading Biblical characters, at each period of the history. As each epoch and each phase of the story is given a separate presentation, the occasional confusion, which is one of the prominent faults of most works of this kind, is wholly avoided.

INTRODUCTION TO THE STUDY OF MODERN FOREST ECONOMY. Pp. 228. FORESTS AND FORESTRY IN NORTHERN RUSSIA, AND LANDS BEYOND. Pp. 279. By JOHN CROUMBIE BROWN, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers.

THESE are new volumes of the series of works on forestry which Dr. Brown is giving to the public, largely as a labor of love. It is an encouraging sign of the spirit of the times, in relation to this subject, that his efforts to fix attention on it are appreciated, and his books are well received both at home and in America. The first of the volumes named here assumes that forestry, or forest science, "relates to everything connected with forests, or pertaining thereto—EVERYTHING." In its three parts, which are further divided into chapters and sections covering details, are given what relate to the extensive destruction of forests, and its evil consequences; the "Elements of Modern Forest Economy"; and "Forest Administration." In the second volume are given descriptions of the forest-lands of the several forest districts of Russia and "Nova Zembla and Lands beyond"; forest exploitation as practiced upon them; and accounts of the physical geography, flora, paleontological botany, and fauna of the several regions.

SOUTH CAROLINA. Resources and Population, Institutions and Industries. Published by the State Board of Agriculture. Charleston: Walker, Evans & Cogswell. Pp. 726. (Compiled by Harry Hammond.)

THIS volume gives a full and minute account of the State to which it relates in all

its aspects, and by counties and towns. The general physical characteristics of South Carolina as a whole are described in the introductory chapter, while the six chapters that follow it are devoted to the several "regions" into which the State is divided, according to the character of their topographical features and products, viz.: the "Coast Region," the "Lower Pine Belt, or Savannah Region," the "Upper Pine Belt," the "Red Hill Region," the "Sand Hill Region," the "Piedmont Region," and the "Alpine Region." The ninth chapter is devoted to the water-powers, and in the three chapters that follow it are given lists of the vertebrate animals, of the invertebrate fauna, and of the plants of the State. In the second part of the volume are reviewed the statistics, relations, and movements of the population, the vital statistics, and the institutions of the State; a sketch of "Education" is inserted; and full information is given respecting the churches, occupations, the insane, etc., the history and present condition of transportation, "Debt and Taxation," and the "Farms of South Carolina."

PUBLICATIONS RECEIVED.

Opium Addiction among Medical Men. Pp. 9. The Genesis of Opium Addiction. Pp. 8. By Dr. J. B. Mattison, Brooklyn, N. Y.

A Periodical Painful Affection. Pp. 19. Irritation of the Prostate. Pp. 7. By Harvey Reed, M. D., Mansfield, Ohio.

The Volcanic Problem from the Point of View of Hawaiian Volcanoes. By W. L. Green, Honolulu. Pp. 7.

Man in the Tertiaries. By Edward S. Morse, Salem, Mass. Pp. 12.

"Journal of the Elisha Mitchell Scientific Society," 1883-1884. J. W. Gore, Secretary, Chapel Hill, N. C. Pp. 97.

Yellow Fever at Norfolk and Portsmouth, Virginia, in 1855. Pp. 19. Reparative Surgery. Pp. 10. By F. B. Stevenson, M. D., U. S. Navy.

Tobacco: Its Uses and Effect on the Human System. By Lemuel Clute, Ionia, Mich. Pp. 6.

Massachusetts Agricultural Experiment Station, Amherst. Bulletin No. 11. Pp. 12.

New York Agricultural Experiment Station. Report for 1883. Albany: Weed, Parsons & Co. Pp. 279.

The History and Philosophy of Atheism. By Professor A. H. Darrow, Hartford, Kansas. Pp. 71. 25 cents.

Bureau of Iowa Agricultural College, Department of Entomology. By Herbert Osborn, Ames, Iowa. Pp. 56, with Plates.

Descriptive Catalogue of Sections (Microscopical) of Rocks. By Dr. M. E. Wadsworth. Boston The Prang Educational Company. Pp. 20.

Chicago Manual Training-School. Inaugural Address of the Director, Henry H. Belfield. Pp. 15.

Proper Medical Education. By Henry Leffman, M. D. Pp. 3.

Protection and Free-Trade To-Day. By Robert P. Porter. Boston: J. R. Osgood & Co. Pp. 48. 10 cents.

Diccionario Tecnológico. Part VIII. By Nestor Ponce de Leon. New York: N. Ponce de Leon. Pp. 48. 50 cents.

The True Issue (Tariff Reform). By E. J. Donnell. New York: G. P. Putnam's Sons. Pp. 79.

A Dictionary of Music and Musicians. Part XIX. By George Grove, D. C. L. New York: Macmillan & Co. Pp. 128. $1.

Alexander the Priest. By William A. Swank. Pp. 40.

Suggestions respecting Educational Exhibit (Bureau of Education). Washington: Government Printing-Office. Pp. 281.

Russell's Improved Process for the Lixiviation of Silver-Ores. By C. A. Statefeldt, New York. Philadelphia: Sherman & Co. Pp. 72.

On the Amount of the Atmospheric Absorption. By S. P. Langley. Pp. 18.

Fifth Annual Report of Sapporo Agricultural College. Japan, 1881. Pp. 84.

The Psychical Relation of Man to Animals. By Joseph Le Conte. Pp. 26.

Town and County Government in the English Colonies of North America. By Edward Channing. Baltimore: N. Murray. Pp. 57. 50 cents.

Modern Low-Cost Houses: Shoppell's Building Plans. New York: Co-operative Building-Plan Association. Forty Designs. 50 cents.

The Steam-Engine Indicator and its Use. By William Barnet Le Van. New York: D. Van Nostrand. Pp. 169. 50 cents.

Ogilvie's Handy Book of Useful Information. Compiled by J. S. Ogilvie. New York: J. S. Ogilvie & Co. Pp. 128. 25 cents.

Correspondences of the Bible. The Animals. By John Worcester. Boston: Massachusetts New Church Union. Pp. 294. $1.

Essays by Wheelbarrow. Chicago: "Radical Review." Pp. 132.

Practical Work in the School-Room. Object-Lessons on the Human Body. New York: A. Lovell & Co. Pp. 157.

Education by Doing. By Anna Johnson. New York: E. L. Kellogg & Co. Pp. 109.

"The Jukes." Studies of Criminals. By R. L. Dugdale. New York: G. P. Putnam's Sons. Pp. 120, with Charts. $1.25.

Tableaux de la Révolution Française (Introductory French Reader). By T. F. Crane and S. J. Brun. New York: G. P. Putnam's Sons. Pp. 311. $1.50.

A Grammar of the German Language. By H. C. G. Brandt. New York: G. P. Putnam's Sons. Pp. 278. $1.50.

A Reader of German Literature. By W. H. Rosenstengel. New York: G. P. Putnam's Sons. Pp. 402. $1.50.

An Outline of the Future Religion of the World. By T. Lloyd Stanley. New York: G. P. Putnam's Sons. Pp. 588. $3.

Life and Labor in the Far, Far West. By W. Henry Barneby. London and New York: Cassell & Co. Pp. 432. $2.

Mineral Resources of the United States. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 813.

The National Dispensatory. By Alfred Stillé, M. D., and John M. Maisch, Phar. D. Philadelphia: Henry C. Lea's Son & Co. Pp. 1,755.

American Newspaper Annual, 1884. Philadelphia: N. W. Ayer & Son. Pp. 994. $3.

Transactions of the Linnæan Society of New York. Vol. II. New York: Published by the Society. Newbold T. Lawrence, Corresponding Secretary. Pp. 233, with Plate.

POPULAR MISCELLANY.

British Association Addresses.—Professor Roscoe's address before the Chemical Section was on "The Progress of Chemistry since 1848." The author made the year 1848 a dividing line between the epoch of Berzelius, which closed then, and that of Dumas and Wurz, which closed in 1884. The differences between the two epochs are shown in the distinct views which were entertained as to the nature of a chemical compound. According to the older notions, the properties of compounds were determined largely by the qualitative nature of their constituent atoms, and these were arranged so as to form a binary system. According to the newer view, it is mainly the number and arrangement of the atoms in a molecule that regulate the characteristics of a compound, which is to be regarded, not as built up of two constituent groups of atoms, but as forming a single group. The theory of substitutions, the relation of atomic weights and volume-combination, the prominent part assigned to organic radicals, the doctrine of valency or atomicity, and Mendelejeff and Lothar Meyer's periodic law, under which we may predict the nature and place of as yet undiscovered elements, and the study of isomeric phenomena, are also distinctive marks of the later chemistry. The artificial synthesis of a few coloring-matters and of kairine, a febrifuge as powerful as quinine, are among its most noteworthy achievements. Of the work that has been done in the determination of chemical constants, the labors of Mallet on aluminum, of J. P. Cooke on antimony, and of Thorpe on titanium, are especially mentioned. The speaker gave accounts of the progress that has been made in spectrum analysis, and the close distinctions of the molecular properties and constitution of bodies which it has made possible. Other indications of progress are given in Sir William Thomson's speculations on the probable size of the atoms; Helmholtz's discussion of the relation of electricity and chemical energy; and the theory of the vortex-ring constitution of matter, as suggested by Sir William Thomson and worked out by Mr. J. J. Thomson. Much experimental attention is now given to thermo-chemistry. The discovery of the liquefaction of the gases by Pictet and Cailletet, including Andrews's discovery of the critical point, indicates a connection, long unseen, between the liquid and the gaseous states. Deville's investigations of the laws of dissociation have opened out entirely fresh fields for research, and given new, important, and interesting views concerning the stability of chemical compounds. Professor Roscoe considered the best methed of educating chemists to consist in giving them as sound and extensive a foundation in the theory and practice of the science as their abilities will allow, rather than in forcing them prematurely into original preparations and investigations.

Mr. W. T. Blanford, President of the Geological Section, presented some remarks upon contradictions which had been observed in certain districts, in the determination of the age of geological formations as indicated by their fossils. The most of them occur where a land or fresh-water fauna or flora assigned to a particular formation rests upon a marine bed of apparently later origin: as in Greece, where the supposed Miocene fauna of the Pikermi beds overlie strata with Pliocene mollusca; and in certain described places in India, Australia, and South Africa. Only one case of contradiction between two marine formations is known, and that is in dispute. In making choice between the two witnesses, geologists take the marine formations; for marine faunas and floras are more widely diffused than those of the land, and more nearly uniform throughout the world. Thus, of fishes, eighty families are typically marine, and twenty-nine are confined to fresh water; of the first, fifty are universally or almost universally distributed; while of the second, only one is found in five of Wallace's regions, and not one is met with in all the six regions. Among plants, so uniform is the marine vegetation of the world, that no separate regions can be established in the ocean, while Drude makes fourteen on the land. It appears to the author that at the present day the difference between the land faunas of different parts of the world is so vastly greater than that between the marine faunas that, if both were found fossilized, while there would be but little difficulty in

recognizing different marine deposits as of like age from their organic remains, terrestrial and fresh-water beds would in all probability be referred to widely differing epochs, and that some would be more probably classed with a past period than with others of the present time. The idea that marine and terrestrial faunas and floras were similar throughout the world's surface in past times is so ingrained in paleontological science that it will require many years yet for the fallacy of the assumption to be generally admitted. No circumstance has contributed more widely to the belief than the supposed universal diffusion of the carboniferous flora. The evidence that the plants which prevailed in the coal-measures of Europe were replaced by totally different forms in Australia, despite the closest similarity between the marine inhabitants of the two areas, should go far to dispose of this belief. Hence, determinations of the age of terrestrial beds based upon their fossil faunas and floras should not be accepted as fixed unless they are accompanied by evidence from marine beds.

Discussing the "Physiology of Deep-Sea Life" in the Biological Section, Professor Moseley, of the Challenger Expedition, having recognized the value of the work that had been done in deep-sea investigation in the United States, spoke of the importance to the physiologist of a knowledge of the conditions under which gases occur in a state of absorption in the ocean-waters. Professor Dittmar's researches show that the presence of free carbonic acid in ocean-waters is an exception. Hence, the solution which some shells undergo at certain depths is probably due, not to the presence of free acid, but to the solvent action of the sea-water itself. Oxygen is present in all sea-water, being derived from the surface, but the amount diminishes, on account of the oxidizing that is always going on, with increase of depth. M. Regnaud's experiments on the effects on organisms of high pressures, corresponding with those of certain sea depths, show that a fish without a swimming-bladder, or one with the bladder emptied of air, may be subjected to a pressure of 100 atmospheres, or 650 fathoms, without injurious effect; at 200 atmospheres, or 1,300 fathoms, it becomes torpid, but soon revives when the pressure is removed; while at 300 atmospheres, or about 2,000 fathoms, the fish dies. The results of these experiments would probably have been greatly modified, if plenty of time could have been given for the fish to accommodate itself to the change of pressures and the conditions in which it moves slowly from one depth to another be imitated. M. Paul Bert's experiments upon the effect on aquatic organisms of water subjected to the pressure of compressed air—a very different condition—show fatal results at fifteen and even at seven atmospheres. A large proportion of the food-supply of the deep-sea animals appears to be derived from life on the ocean-surface, or that which is brought to the surface by rivers from the land sinking down to it. Deep-sea life appears to diminish in abundance as the coasts are receded from. More may be known on this subject when we have learned more about pelagic vegetable life, with which our acquaintance is now imperfect. If it shall be ascertained that the deep sea derived its main supply from the coasts and land-surfaces in the early periods, there can have existed scarcely any deep-sea fauna until the littoral and terrestrial faunas and floras had become well established. It still appears impossible to determine any successive zones of depth in the deep-sea regions, characterized by the presence of special groups of animals. Some groups seem to be characteristic of water of considerable depth, but representatives of them struggle up into much shallower regions. This fact places a difficulty in the way of determining the depths at which the geological deposits were formed. Something may be learned of the depths of modern deposits by the examination of their microscopical composition and the condition of the shells and spicules. Great uncertainty prevails as to whether, or to what extent, the intermediate waters, which are held to include about eight ninths of the bulk of the entire ocean, are inhabited by animals. A feature of the deep-sea fauna is the general absence from it—except as to mollusks and brachiopods—of palæozoic forms. This fauna has, doubtless, been derived almost entirely from the littoral fauna, which also must have preceded,

and possibly given rise to, the entire terrestrial fauna. And because the ancestors of nearly all animals have passed through a littoral phase of existence, preceded mostly by a pelagic phase, the investigations now carried on, on the coasts, in marine laboratories, throw floods of light on all the fundamental problems of geology.

General Lefroy, in his address before the Geographical Section on "Recent Geographical Discovery" referred to the more exact identification of the pole of vertical magnetic attraction or magnetic pole, which was visited by Ross and by officers of the Franklin Expedition, and nearly reached by McClintock and Schwatka; and of the focus of greatest magnetic attraction, which is near Cat Lake, and has never been visited; and the exploration of the newly discovered great lake Misstassini, as worthy objects of Canadian research. Among the later achievements of geographical exploration are the journey of Mr. Thomson through the region between Mount Kilimanjaro, Lake Nyanza, and Mount Kenia, touching Lake M'Baringo on which no European had ever before stood, among tribes who had never seen a white man; Stanley's and De Brazza's continued explorations of the Congo region; and the work of Dr. Pogge, Lieutenant Wissman, and the Portuguese explorers in the southern Congo, Upper Quango, and Loando regions. According to Dr. Pogge, much of the interior of Africa belongs, by reason of its elevation above the sea, to a far more temperate zone, and is better suited to European constitutions than its geographical position promises. In illustration of the rapid extension of white occupation in Central Africa, a table is given of about one hundred and twenty actual centers of communication or trade, or of missionary instruction, now established there. Lake Nyassa is becoming a busy inland sea. There are two steamers upon it, and one on the river Shiré; upon Tanganyika three. Donkeys have been already introduced, with good promise, by the universities' missionaries and the African Lakes Company, although they have not been a success on the Congo. The African Lakes Company, of Glasgow, has ten small depots between Quillimane and Malawanda on Lake Nyassa, and from this place a practicable road of two hundred and twenty miles has been carried to Pambete, on Lake Tanganyika.—In Asia, Mr. W. W. Graham has reached in the Himalayas an elevation of 23,500 feet, or about 2,900 feet above the summit of Chimborazo; some progress has been made, by the aid of disguised Indians, in the surveys of territories from which Europeans are excluded; the primary triangulation of India, begun in 1800, is practically completed; and the upper Oxus has been traced from its sources in the Punjaub. Australia has been crossed again from east to west, and also through four hundred miles of new country north of Cowarie Station on the Warburton River, and the usefulness of camels in that service has been demonstrated.—The international circumpolar expeditions have added, perhaps, to local knowledge, but not much, so far as reported, to geography generally. The discoveries made by Greely's party are mentioned appreciatively. The results of the marine researches of the Talisman and the Dacia in the Atlantic Ocean are of great value. Reference was made to the extension of railroads in Mexico, South America, the Senegal, the Caucasus, and Central Asia, as marking steps in the advance of man's mission to subdue the earth and replenish it; and the importance was insisted upon of obtaining accurate map delineations in aid of the exact determination of boundary-lines and the avoidance of disputes about them.

"The Relation of Mechanical Science to the other Sciences" was the topic of Sir F. J. Bramwell's address before the Mechanical Section. He called attention to the fact that it was the engineer who had made a meeting of the Association in Canada possible. Every one must agree that the engineers are those who make the greatest practical use, not only of the science of mechanics, but of the researches and discoveries of the members of the other sections of the Association. Knowledge of the laws of heat is requisite in the construction of thermal motors; in the applications to metallurgy, as exemplified in the hot blast, in the regenerative furnace, in the dust-furnace of Crampton, in the employment of liquid fuel, and also in operations connected with the

rarer metals, the oxygen-furnace, and the atmospheric gas-furnace, and, in its incipient stage, the electrical furnace. The success of air-refrigerating machines and the economic distillation of sea-water are dependent on the same knowledge. Engineering and electrical science are brought into close relations in the construction of telegraph and cable lines, in the development and application of dynamo-machines and dynamo-energy, and in electric lighting, telephony, and microphony. In navigation, the engineer avails himself of optical science in the equipment of lighthouses; of pneumatics in Sir William Thomson's apparatus for taking quick soundings, and of magnetic science in his adjustment of improved compasses. Mathematical principles enter into the construction of ship-models. In the processes of the preparation from the ore of various metals, "it is essential that the engineer and the chemist should either be combined in one and the same person, or go hand in hand." The chemist and the microscopist have to be called in to ascertain the purity of every contemplated source of water-supply; and the chemist, when it is desired to convert a hard water into soft. Engineers must consult the geologist before they can intelligently make estimates of the works they are about to undertake. In biology, the engineer learns from the botanist the qualities of the various woods he occasionally uses in his work, and has the "germs" in view in arranging for the purity of water-supply and for ventilation. Lastly, great works of engineering facilitate geographical exploration, and are called into existence by the dictates of the economist. The speaker closed his address with a tribute to the memory of Sir William Siemens.

Cultivation of Cacao.—The cacao-tree flourishes in the hot regions of America, and has been cultivated since the conquest in Mexico, Guatemala, and Nicaragua. To secure success, the cacao-plantation must be made in new land, for the tree requires a rich, deep,' and moist soil, and heat. The best situation is cleared forest-land, so inclined as to permit its being irrigated. The cultivation of the trees often ceases to be profitable when the temperature falls below 73°. The cacao seldom blossoms till it is thirty months old. The planters destroy the first flowers, in order to prevent fruiting before the fourth year. There are few plants in which the flower is so small and so disproportioned to the size of the fruit. A bud measured by M. Boussingault, at the time of its expansion was not more than four millimetres broad. The flesh-colored corolla was composed of ten petals surrounding five silver-white stamens. The flowers did not appear singly, but in bouquets on every part of the trunk, on the principal branches, and even on the salient wood-roots. The fruit comes to maturity in about four months after the fall of the flowers. It is about ten inches long and three or four inches in diameter, slighty curved, weighs three hundred or five hundred grammes, and is divided into three lobes. Its color varies from a greenish-white to a red-violet. The pericarp is furrowed longitudinally within; the flesh or pulp is rosy-white and acid, and generally envelops twenty fine, white, oily kernels which in drying assume a superficial brown tint. Two principal crops are harvested every year, but on large plantations the gathering is going on all the time, and it is not uncommon to see trees bearing both flowers and fruits at the same time. After breaking the shell, the nuts are taken out and exposed to the sun. In the evening they are piled up under a shed. An active fermentation soon sets in, which must not be allowed to go too far, and, accordingly, the nuts are on the next day spread out in the air. The cultivation of a cacao-plantation does not demand much labor. One man can take care of a thousand trees. The most serious difficulties are the dangers from storms, which are very destructive to the fruit; otherwise the principal duty of the attendant is to protect the crop from animals. The cacao is shelled by roasting at a moderate heat, in which process it acquires, like the coffee-bean, an odor arising from a minute proportion of a volatile principle which it contains. This is the peculiar aroma which we perceive in chocolate. The cacao-beans are rich in nutritious principles, containing a fat, nitrogenous substance analogous to albumen and caseine, theobromine and ternary compounds, all of which vary somewhat in their relative quantities. The theobromine is almost identical with the caffeine of coffee and the theine

of tea, and is essentially the same principle that gives value to those substances and to the *maté* of Paraguay and the coca of Peru. Thus, in the several drinks prepared from these substances, the Chinese, the Arabs, and the Indians of Mexico and South America enjoy the influence of the same cheering but not inebriating agent. Cacao and chocolate differ from the other beverages named in that they contain a notable proportion of nutritious elements which exist in the others only in minute quantities.

The Question of Short-Sightedness in French Schools.—A commission appointed by the French Government to investigate the question of short-sightedness in schools recently made a report through Dr. Gariel. It declares that the affection is caused by the efforts of the pupil to accommodate his vision to the requirements of the position in which he finds himself, and by his bending over. These effects are provoked by defective lighting, badly fitting seats and desks, bad methods of writing, premature instruction, and too fine print. The commission recommend, for books, yellowish-tinted paper; that each line with its white should occupy a minimum vertical space of 3·384 millimetres; and that there should not be more than seven letters to each current centimetre of text. Furthermore, every book should be rejected which is not readable to good eyes eighty centimetres or thirty-one inches off in the light of a standard candle one metre away, and every map that is not distinct under the same conditions at a distance of forty centimetres, or sixteen inches. In regard to habit in writing the committee exacts George Sand's condition of "straight writing, on straight paper, with a straight body." Instruction should not begin too early, at least not in writing on paper; and the child should not be put at it till it has learned to trace the letters on a board, upright, and without linking them together. In the matter of seats and desks, the committee appear to exact that the horizontal distance between the edge of the desk and the front of the seat one or two places back shall be rigorously negative; then the child will not be able to bring his chin down to his desk. The back should be inclined to fit the pupil's back and give a position of rest, and the desks should slant so that the paper lying on them should be perpendicular to the visual rays. The larger classes should have movable chairs. If there is not enough light, the pupils should be allowed to hold their books so that they can get the most of it. An Italian journal has published a model of a seat well adapted to fit the back of various sizes to suit deficient eyes, and so adjusted that the child can take a nap, if sleepy, without suffering. The hardest question the committee had to meet was that regarding the admission of light. It was agreed that a sufficient illumination of the darkest part of the room should be the standard, and that a bit of sky not less than thirty centimetres, or twelve inches, in vertical diameter ought to be visible from the least favored spot; but the expediency of bilateral illumination does not yet seem to be determined to the satisfaction of all: some thought cross-lights might give trouble; others suggested that this could be avoided by making the light from one side much stronger than from the other, or by making the light come from above or from behind.

Natural Gas as a Source of Fuel.—An important change in the conditions of manufacturing in Pittsburg is promised by the introduction of natural gas as fuel in place of coal. The gas, which is principally carbureted hydrogen, or the fire-damp of the mines, is obtained abundantly in the neighborhood of the city, and even within its corporate limits, by boring wells. Much of it has been met in the past in boring for petroleum, and when found under such circumstances it was regarded as a nuisance. Some of the wells thus discovered have already been applied to economical uses, and found as valuable as if they had been petroleum-wells. Such wells are employed for burning brick at New Cumberland, and in the manufacture of pottery at East Liverpool, of cutlery at Beaver Falls, and of glass-ware at Rochester. The gas of six wells is brought through pipes twenty miles to the city and used to heat the boilers of an iron-manufactory; and it has been found that, where the distance of the supply is so short that the gas can be brought in without its pressure being wholly lost in piping, it can be made a valuable addition to the

resources for fuel. A very fine vein of gas has been found by sinking a well within the limits of the city, and several manufacturers have begun boring for it on their premises. Twenty-six wells are now furnishing gas to manufacturers in the Pittsburg district, and new ones are added from time to time. They are estimated to be furnishing a supply of fuel equivalent to from 5,000 to 7,000 tons of coal daily, or from 1,800,000 to 2,500,000 tons a year. The gas makes a nice and even fire in grates and stoves, but objection is made to its use in private houses on account of its freedom from odor, by which the detection of leaks is prevented, and the danger is incurred of the air of the house being fatally poisoned before any one becomes aware that anything is wrong. Its light is too weak to make it suitable for illuminating purposes. Its advantages over coal lie in the possibility of supplying it at much less expense, and in its entire freedom from soot and smoke—a matter of extreme importance in such a city as Pittsburg.

NOTES.

AN "American Electrical Exhibition" will be opened in the Massachusetts Charitable Association Building, Huntington Avenue, Boston, November 24th, and will be continued till January 3, 1885. It is intended to make the exhibition complete and comprehensive in every particular, and to exceed in novelty any that has ever been held in New England. The rooms will be open for the reception of exhibits from November 5th to November 19th. Applications for space must be made by November 1st. Communications should be addressed to "American Electrical Exhibition, Post-Office Box 1130, Boston, Massachusetts."

MR. D. H. TALBOT describes, in the "American Naturalist," a specimen of the ground squirrel in a state of hibernation which he had an opportunity of observing. It was rolled up in a perfect ball, with its head resting forward of the root of the tail, and the tail curled carefully up on the body. It was resting in a perfectly closed ball of hay twelve or fourteen inches in diameter in the center of a hay-stack. It was evidently alive and healthy when found, though quite dormant, but either in consequence of having been inconsiderately exposed unwrapped to extreme cold by the finder, or of some change that took place while it was in Mr. Talbot's keeping, it grew limp, suffered hæmorrhage, and died.

A CORRESPONDENT calls attention to a clerical error—a genuine case of what Richard Grant White would call heterophemy—that escaped notice in the proof-reading, by which we were made, in the September number, in recording the death of Henry Watts, to say that he had been a "demonstrator of anatomy" in University College, London. "Director in the laboratory" was what it should have been, and what was intended.

MR. W. H. PREECE stated in the British Association that he had been fairly successful in telephoning through the cable between Dublin and Holyhead, a distance of sixty miles. Accurately heard conversation, however, could not be carried on through cables beyond a distance of twenty-five miles; and it seemed at present impracticable to use underground wires in cities for distances of more than twelve miles. On overground wires he had no difficulty, with an arrangement of double lines, in speaking through two hundred and forty miles.

PROFESSOR CLAYPOLE read a paper, before the Geological Section of the British Association, on the crumpling of the earth's crust as shown by a sixty-five-mile section across Huntingdon, Juniata, and Perry Counties, Pennsylvania, in which he estimated by mathematical methods that the strata had been shortened, by the foldings they had undergone, from an original length of about one hundred miles. That the contraction had been so great was disputed by some of his hearers, but Professor Claypole held to his conclusions.

THE commission, appointed by the French Minister of Public Instruction, to verify the results of M. Pasteur's experiments on the prevention of hydrophobia by inoculation, has pronounced them decisive. The problem whether inoculation of a human being, after he has been bitten, can be relied upon to secure him against contracting the disease, is still under investigation. Time and many subjects will be needed before a rigorously exact solution of it can be reached.

THE temperatures of the boiling-points of the liquid forms of certain gases, as determined by Mr. Wroblewski, were given in our September number with the minus-signs undesignedly omitted. Most readers would understand, as of course, that temperatures below zero were intended. For the benefit of those to whom this may not have occurred, we repeat the temperatures: oxygen $-299°$ Fahr.; atmospheric air$-314°$; nitrogen $-315·5°$; carbonic oxide $-314·4°$; and we may now add, hydrogen$-351°$.

SIR JOHN LAWES and Dr. Gilbert maintained, in a paper before the British Association, that the view which has been held

that a soil is a laboratory and not a mine, is erroneous; for not only the facts adduced by them in previous papers, but the whole history of agriculture, so far as we know it, show that a fertile soil is one which has accumulated within it the residue of ages of previous vegetation, and that it becomes less fertile as this residue is exhausted.

Dr. Cobbold, an eminent authority on the subject, asserts that the danger of eating parasites in fish used as food is much exaggerated, and that there is extremely little of it. If the fish are only moderately boiled, the parasites will all be killed, and, if they are not, not one in a thousand of them will find itself at home enough in the human stomach to do any harm. Professor Huxley also declares that the thread-worm of the mackerel is harmless, and that the idea of its being a possible cause of cholera is sheer nonsense; and he thinks it outrageous that the suggestion has been made.

Masks of mica are made at Breslau for the use of workmen who are exposed to high temperatures, to acid vapors, or to metallic sparks. They are found to protect the eyes better than glasses, while there is space enough between them and the eyes to permit spectacles to be used also. The plates of mica are fixed in metallic supports protected with amianthus, and the neck and shoulders of the workman are covered with a hood of that substance.

The Eilsitt bridge, Lyons, France, is called "the singing-bridge," on account of the musical sounds it emits at different parts of its course, "when at particular moments one might believe it haunted by legions of invisible naiads pursuing the passengers with their plaintive melodies." The bridge is furnished with a stone parapet, which is pierced at intervals for light, with rectangular openings having their ends rounded off in semicircles. The effect of this passage, with the air-currents rushing through it, is that of a flute, of which the windows represent the holes. The tones vary considerably at times in intensity, with but little difference in their pitch.

The prairie-wolf has been introduced into Epping Forest, England, and appears to be breeding freely there. The animals have been confounded by some persons with cubs of the fox, and described by others as "strange animals from foreign parts." One of them was recently offered to Mr. Bartlett, Superintendent of the London Zoölogical Gardens, who, doubting whether it might not be a hybrid of some kind, visited the forest to learn something more about its real character. The less frequented parts of the forest seem well suited to the habits of the animals, and they promise to thrive.

Dr. Richardson has sounded a note of warning against the too hasty and complete acceptance of the bacillus theory for the origin of every kind of infection, to the neglect "of all the preceding clinical history." He asks: "Upon the evidence of how many or how few men does the bacillus hypothesis rest? On what reasoning does it rest? Who has separated, in relation to it, coincidence from causation?" To ask these questions, or to heed them, is not necessarily to question the validity of the bacillus theory, but simply to pause and review, and ask for the proof of it.

The question whether the water of a river like the Thames, when once polluted by sewage, can be made fit for drinking purposes, either by the oxidation incident to its own flow or by artificial filtration, was again up for discussion recently before the London Society of Arts. Dr. Frankland took the negative side upon it, and insisted that the Thames's supplies to London should be abandoned; while many eminent engineers and a few chemists positively contradicted both his data and his conclusions. Mr. W. Mattieu Williams suggests that the force of the latter gentlemen's opinions is somewhat detracted from by the fact that most of them are concerned in the construction of filter-beds and other engineering appliances for river-water purification, or in schemes for chemical precipitations.

The ice-plant of our ladies' window-baskets (*Mesembryanthemum crystallinum*) affords a striking illustration of the elective power which plants have of taking up by their roots from a complex soil the materials proper for them. M. Mangon has cultivated it for several years on the same ground with cabbage, celery, and other plants, and has found that, while the latter plants had their normal composition, the ice-plant, dried and burned, furnished an ash with an amount of chlorine and alkali that astonished him. From one hectare, or two acres and a half of ice-plants, he obtained 1,820 kilogrammes of ashes, containing 335 kilogrammes of chlorine, as much soda, and 588 kilogrammes of potash, the latter of which substances was capable of furnishing 863 kilogrammes of carbonate of soda, or nearly as much as is got from the incineration of one hectare's yield of the salt-works at Alicante. M. Mangon suggests that this plant might be cultivated for a potash-plant, and that it might be made serviceable in removing the excess of alkaline salts from salt grounds.

A correspondent of "Nature" writes from Java that, having recently killed one of the venomous snakes of that island, he noticed the tail of a second snake sticking from its mouth, and found that it had swallowed another individual of the same species, and nearly the same size with itself.

EDWARD BURNETT TYLOR.

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THE REFORMATION IN TIME-KEEPING.

By W. F. ALLEN.

ON November 19, 1883, the daily papers of the United States and Canada, from the Atlantic Ocean to the Rocky Mountains, contained more or less elaborate accounts of the change from local to "standard time" which had been made on the previous day. Comparatively few among the millions of people who read these accounts took the trouble to investigate the actual meaning of the change or the arguments in its favor. It appeared to be the work of practical railway managers, and to be favored by leading scientists. Watch-makers agreed to and aided the change, and few other persons were apparently interested. So the people quietly acquiesced, reset their watches a few minutes faster or slower, and for the most part soon forgot that any but "standard time" had ever been in use.

In the present generation we have become so accustomed to the use of accurate time and the ready means of obtaining it, that we hardly realize how dependent we are upon it. Were it possible to suddenly destroy all clocks and watches in any given center of population among civilized nations, while all other surroundings of modern development remained as before, we can scarcely conceive of the endless confusion that would arise. Only by contemplating the results of such a catastrophe can we fully understand what an important part the knowledge of accurate time plays in our every-day affairs.

Man shares with the inferior animals the knowledge and the use of the simplest and earliest division of time into day and night, and in a more restricted sense into seasons. The division of the day into minor parts has been developed by man as necessity or convenience required. It has not been many years since watches were made with

hour-hands only, and the general use of the finer divisions into minutes and seconds is almost entirely the outgrowth of the requirements of modern civilization. Astronomical time-keeping is not here considered. By the Babylonian system of dividing the day, which was used by the Jews and other Oriental nations, the time between sunrise and sunset was portioned into twelve equal parts at all seasons of the year, the hour varying in length with the season. If this method of division still prevailed, the hours in New York city would vary in length from about forty-six to about seventy-five of our present minutes. In the Arctic regions the inapplicability of this system to general use would reach its climax of absurdity.

The general facts upon which all systems of time-keeping are based are commonly understood, but the details are seldom referred to.

The most primitive kind of timepiece is a sun-dial. Reduced to its simplest form, a sun-dial consists of a straight pole erected upon a permanently fixed circular plate, the shadow of the pole indicating midday when it coincides with a line drawn due north from the base of the pole, the pole being erected upon a line parallel with the axis of the earth. The other hours of the day are indicated by marks upon the circular plate upon which the shadow of the pole successively falls.

When the sun-dial was invented can not be stated. It was of very ancient origin, and is mentioned in the thirty-eighth chapter of Isaiah. The clepsydra, or water-clock, and the hour-glass, although very ancient, must from their nature have been invented subsequent to the sun-dial. But sun-dials, of which there are about a dozen different kinds, although common, were never in such general use as clocks are in modern times, and were philosophical rather than popular instruments. The clock was invented about 1379, and the pendulum as a regulating power in 1657.

The rapid development of the science of horology in the present century has been almost coincident with and in no small degree dependent upon the construction and operation of railway and telegraph lines. The needs of these great engines of modern civilization created a general demand for exactness in time reckoning which had never existed before. It was required both for the use of their employés and for the public which patronized their lines.

A sun-dial being stationary, when properly made and adjusted, exhibited solar time correctly, and a watch regulated from the dial by the equation of time would also be correct for that particular spot, but the moment the owner of the watch began to move east or west his time-piece no longer registered correct time, and when he traveled with the speed of a railway-train the error was rapidly exaggerated.

The necessity for exactness before mentioned, and the impossibility of adhering to local time, early attracted the attention of railway managers, and caused them much perplexity and annoyance. With the rapid construction of railway lines, the commingling of the various lo-

cal standards soon became decidedly intricate. Travelers were greatly inconvenienced by the lack of knowledge of the standard upon which the time of trains as advertised was based, and to such the situation was full of difficulties. Some of these difficulties were stated in an "open letter" published in "The Century" for September, 1883. The subject in its practical aspect also attracted the attention of scientists and scientific societies. It became a prominent topic of discussion at meetings of the American Metrological Society, the Association for the Advancement of Science, and the Society of Civil Engineers. Although astronomers use sidereal time, based upon the position of the stars, and not of the sun, in common with many other scientists they were generally warmly interested in the subject.

The local time kept by clocks is an average of solar time, and is properly designated "mean time," as distinguished from the variable time shown by the sun-dial. No clock or watch can be made to keep the time as shown by the sun-dial, and this new system of time-keeping, therefore, became necessary when clocks and watches were invented. The relation between mean and apparent time, and what is meant by "the equation of time," may be seen at a glance by reference to the accompanying diagram. Mean time being represented by the right line graduated for the several months of the year, the variation of apparent time is shown by the curved line entwined around it. In other words, a line drawn through the several positions of the sun at mean noon will describe the curves as indicated. For reasons which need not here be stated, the diagram will be found generally correct for one year only out of four; but, upon the scale by which the diagram is drawn, this error is infinitesimal. It is hardly necessary to state that the principal cause of the variation between mean and apparent time is "the obliquity of the ecliptic to the equinoctial."

Apparent time is about fifteen minutes slower than mean time about February 10th, and about sixteen minutes faster on October 27th. They agree about April 15th, June 15th, August 31st, and December 24th. If a well-regulated clock were set by apparent time on October 27th, it would be about thirty-one minutes faster than apparent time on the following February 10th. It will be seen that, under such circumstances, clock-time would vary as much from true sun-time as any clock set by the present system of standard time varies from mean time at the most extreme point.

The safe operation of a railway requires that the watches of all its employés upon, or who have occasion to refer to, the same trains should always indicate the same moment of time. Railway-time upon lines running east and west can of course never coincide with mean local time except at a single point, and the longer the line of the road the greater will be the variation. Before the recent change to standard time there were several cases where the railroad-time in use

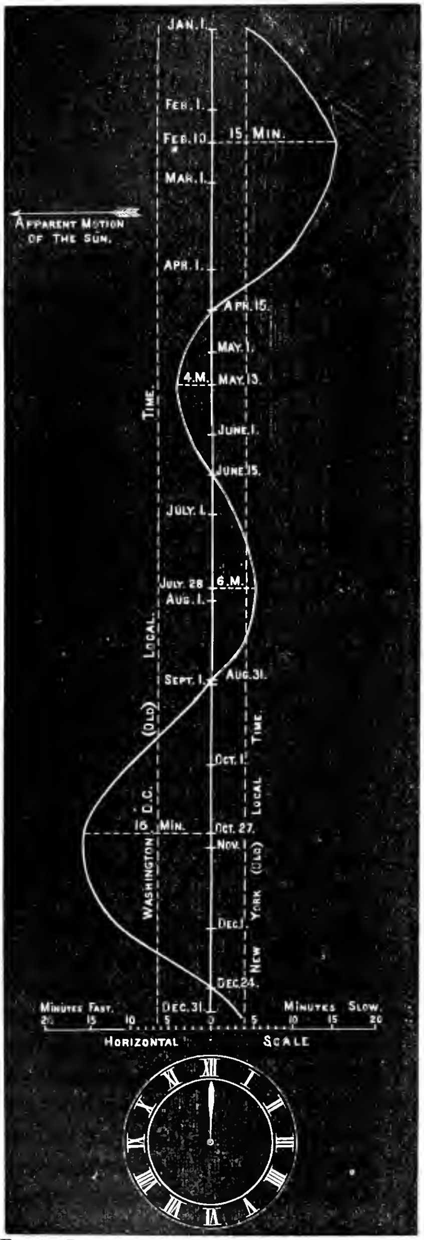


Fig. 1.—Diagram showing comparison of Mean (or Clock) Time with Solar (or apparent) Time, at the several Seasons of the Year. The perpendicular central line represents Mean Time, and the curved line Solar Time, at mean noon.

differed by more than half an hour from mean local time at various points. The inhabitants of the surrounding country at such points, having no standard of reference except the railway-clocks, accustomed themselves to and used railway-time without inconvenience, and in a number of instances, where the railway standard was changed from some cause, the people made the same change in their time-pieces. It was important in connection with railway-trains to keep exact time, and for all other purposes any relative time was sufficiently accurate.

In the early part of the year 1883 there were fifty-three standards of time in use on the railroads and by the people of the United States and Canada. These standards governed sections with no definite limits, and upon railroad lines were apparently inextricably mixed and interwoven. The condition of the matter was abnormal in numerous instances, there being no less than three hundred points where railroads, using different standards of time, crossed each other and exchanged traffic. At almost every city of importance several standards were used by the railways, and in some cases the city time differed from any of them. Local jealousies made the chance of effecting reform apparently hopeless. Many who warmly favored standard time regarded the reform as one unlikely to be soon accomplished.

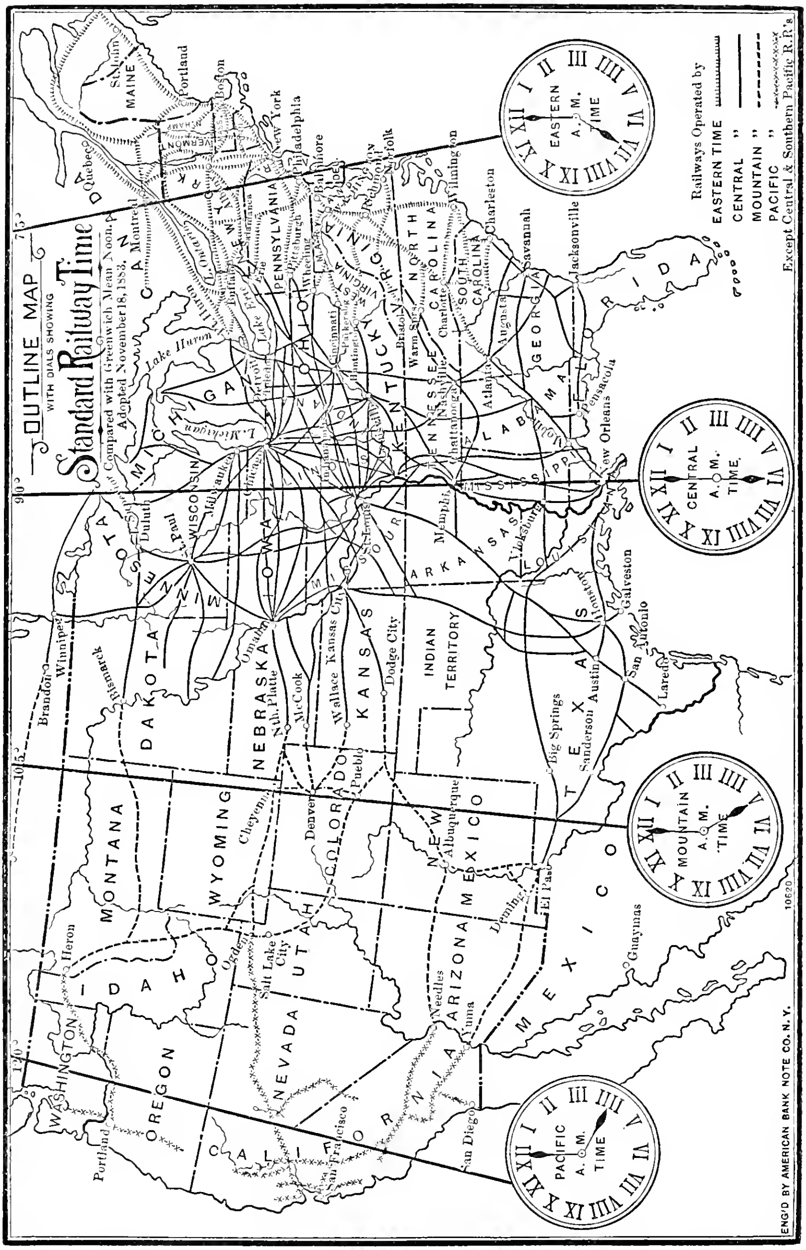
The solution of the problem necessarily required a close and long-

continued study of the peculiarities of the situation. Whatever change was proposed must affect as little as possible the relations which previously existed between railway lines and business communities.

A complete system of standard time was finally devised and submitted in April, 1883, to several railway conventions, assembled to consider other subjects, at which about fifty important companies were represented. The system proposed was deemed practicable, and recommended for adoption, by the railway officials present at these conventions. It involved the total abolition of the use of local time by the public, except at points situated on the governing meridians.

A theory of reform had been under consideration by scientific societies for years, and several systems of standard time had been proposed, founded upon this theory, without practical result. Many investigators of the problem among railway officials and scientists had independently arrived at the conclusion that this theory was the correct one. It was based upon the idea of grouping sections of the country together under the same standard with an even-hour difference between the standards of the adjoining groups. "Eastern standard time," which is the standard of the section in which Boston, New York City, Philadelphia, Washington, etc., are located, is simply the mean time of the seventy-fifth meridian west from Greenwich, and the time kept in all these cities is now precisely alike. The dotted lines on the right and left of the diagram represent the mean times formerly kept at New York city and Washington in their relation to "Eastern" standard time. If a curved line were projected on one of these dotted lines parallel with the curved line on the diagram, and at the same distance, its relation to the central perpendicular line would represent the relation which solar time at New York or Washington bears to the standard time of the seventy-fifth meridian.

In the various discussions of the question a difficulty arose in deciding upon the best governing meridian. Should it be Greenwich, Washington, or New York? Each had its advocates. If this question could be settled, a more serious one arose in determining the proper lines upon which the sections could be divided. The result of its adoption has proved that the system proposed in April, 1883, solved these questions satisfactorily. This system is now in force, and is represented in outline on the map which appears on page 150. It will be noticed that the dividing lines are irregular. Communities near the border which have adopted the system, use the standard east or west of their locations according to the direction in which their business interests lie. In other words, the question is determined by convenience of use, as questions in regard to time-keeping have always been determined. The peculiarities of ownership or operation of the railroads determine their points of change. Legislative enactment will doubtless ultimately define the precise boundaries of the sections of countries to be governed by each standard.


OUTLINE MAP
WITH DIALS SHOWING
Standard Railway Time
Compared with Greenwich Mean Noon,
Adopted November 18, 1883.
EASTERN A. M. TIME
CENTRAL A. M. TIME
MOUNTAIN A. M. TIME
PACIFIC A. M. TIME
Railways Operated by
EASTERN TIME
CENTRAL "
MOUNTAIN "
PACIFIC "
Except Central & Southern Pacific R.R.'s
ENG'D BY AMERICAN BANK NOTE CO. N. Y.
10620

The action of the railroad companies having been assured, the subsequent action on the part of city governments became possible as it could not have been otherwise. Of the labor and means employed to secure this action on the part of the railways and the cities it is unnecessary here to speak. They proved sufficient to accomplish very fully the end desired. More than eighty per cent of all the cities of over ten thousand inhabitants in the United States have adopted standard time.

The adoption of the new standard required a simultaneous change to be made in the railway-clocks and the watches of employés upon nearly every railroad in the United States and Canada, the change varying from one minute and three seconds on the Pennsylvania Railroad to forty-five minutes on the Intercolonial Railway of Canada. The exceptions were two roads in the vicinity of New Orleans, and a few lines in the vicinity of Denver. The change was also slight for some of the St. Louis roads. The Intercolonial Railway adopted the time of the seventy-fifth meridian as a matter of convenience, instead of that of the sixtieth meridian, to which its location would have properly assigned it. So perfect were the preparations that not a single accident at any point is recorded as having been caused by the change. On the day when the new standards took effect, the clocks of about twenty thousand railway-stations and the watches of three hundred thousand railway employés were reset. Hundreds, perhaps thousands, of city and town clocks were altered to conform. How many individuals reset their watches it is impossible to compute, but they could certainly be reckoned by millions. Probably no such singular incident has ever before happened, or is likely to occur again.

At the present time, from the Atlantic Ocean at the eastern extremity of New Brunswick, to the Pacific coast at Oregon, the minute-hands of the railway clocks and watches indicate the same minute of time at all hours, and fully fifty million people regulate their business affairs by standard time.

While a few and for the most part unimportant communities, and some railway companies, did not make the change immediately, so large a majority adopted the system on November 18, 1883, that that date may be fairly taken as the one upon which the reform took effect. Several New England railroads, the Central Vermont Railroad being the most important, commenced to run their trains by "Eastern" standard time on October 7, 1883. The Central and Southern Pacific Railroads west of Ogden and Deming, and their branch lines, are the only railroads in the United States or Canada which do not now use standard time, if we except two purely local roads in Pennsylvania, aggregating less than twenty miles in length. The last to adopt the system were the Union Pacific Railway and the city of Omaha, on May 1, 1884.

The legality of the use of standard time was established by the decision of Judge Holmes, of Massachusetts, that whatever time was in ordinary use by the people of any community was lawful time; and his decision is not likely to be reversed. From an economic standpoint it is difficult to perceive what difference it makes to a laboring-man whether he commences work at a time nominally called seven o'clock or half-past seven, so long as he receives full wages for a full day's work.

Some of the objections raised to the use of standard time as a substitute for local time are as amusing as the famous declaration of the Rev. John Jasper, of Richmond, Virginia. It is urged that the sun was divinely set to rule the day, and therefore to use any but solar time is akin to, if not actually, immoral conduct. As the moon was also set to rule the night, such persons, if logical, should obey that portion of the divine command also. The fact is, that solar time was necessarily abandoned when clocks came into general use, and time based upon one or another arbitrary standard has governed the civilized world ever since. The present system, with its widely extended uniformity, simply conforms to the principle of securing the greatest good to the greatest number, a principle which must everywhere in the end prevail.

AMERICAN ASPECTS OF ANTHROPOLOGY.*

By EDWARD B. TYLOR, D. C. L., F. R. S.

OUR newly-constituted Section of Anthropology, now promoted from the lower rank of a Department of Biology, holds its first meeting under remarkable circumstances. Here in America one of the great problems of race and civilization comes into closer view than in Europe. In England anthropologists infer from stone arrow-heads and hatchet-blades, laid up in burial-mounds or scattered over the sites of vanished villages, that Stone age tribes once dwelt in the land; but what they were like in feature and complexion, what languages they spoke, what social laws and religion they lived under, are questions where speculation has but little guidance from fact. It is very different when under our feet in Montreal are found relics of a people who formerly dwelt here, Stone age people, as their implements show, though not unskilled in barbaric arts, as is seen by the ornamentation of their earthen pots and tobacco-pipes, made familiar by the publications of Principal Dawson. As we all know, the record of Jacques Cartier, published in the sixteenth-century collection of Ramusio, proves

* Vice-President's address to the Section of Anthropology of the British Association at the Montreal meeting.

by text and drawing that here stood the famous palisaded town of Hochelaga. Its inhabitants, as his vocabulary shows, belonged to the group of tribes whose word for five is *wisk*—that is to say, they were of the Iroquois stock. Much as Canada has changed since then, we can still study among the settled Iroquois the type of a race lately in the Stone age, still trace remnants and records of their peculiar social institutions, and still hear spoken their language of strange vocabulary and unfamiliar structure. Peculiar importance is given to Canadian anthropology by the presence of such local American types of man, representatives of a stage of culture long passed away in Europe. Nor does this by any means oust from the Canadian mind the interest of the ordinary problems of European anthropology. The complex succession of races which makes up the pedigree of the modern Englishman and Frenchman, where the descendants perhaps of palæolithic, and certainly of neolithic, man have blended with invading Keltic, Roman, Teutonic-Scandinavian peoples—all this is the inheritance of settlers in America as much as of their kinsfolk who have staid in Europe. In the present scientific visit of the Old to the New World, I propose to touch on some prominent questions of anthropology with special reference to their American aspects. Inasmuch as in an introductory address the practice of the Association tends to make arguments unanswerable, it will be desirable for me to suggest rather than to dogmatize, leaving the detailed treatment of the topics raised to come in the more specialized papers and discussions which form the current business of the section.

The term *prehistoric*, invaluable to anthropologists since Professor Daniel Wilson introduced it more than thirty years ago, stretches back from times just outside the range of written history into the remotest ages where human remains or relics, or other more indirect evidence, justifies the opinion that man existed. Far back in these prehistoric periods, the problem of Quaternary man turns on the presence of his rude stone implements in the drift gravels and in caves, associated with the remains of what may be called for shortness the mammoth-fauna. Not to recapitulate details which have been set down in a hundred books, the point to be insisted on is how, in the experience of those who, like myself, have followed them since the time of Boucher de Perthes, the effect of a quarter of a century's research and criticism has been to give Quaternary man a more and more real position. The clumsy flint pick and its contemporary mammoth-tooth have become stock articles in museums, and every year adds new localities where palæolithic implements are found of the types catalogued years ago by Evans, and in beds agreeing with the sections drawn years ago by Prestwich. It is generally admitted that about the close of the Glacial period savage man killed the huge maned elephants, or fled from the great lions and tigers on what was then forest-clad valley-bottom, in ages before the later water-flow had cut out the present wide

valleys fifty or one hundred feet or more lower, leaving the remains of the ancient drift-beds exposed high on what are now the slopes. To fix our ideas on the picture of an actual locality, we may fancy ourselves standing with Mr. Spurrell on the old sandy beach of the Thames near Crayford, thirty-five feet above where the river now flows two miles away in the valley. Here we are on the very workshop-floor where palæolithic man sat chipping at the blocks of flint which had fallen out of the chalk-cliff above his head. There lie the broken remains of his blocks, the flint-chips he knocked off, and which can be fitted back into their places, the striking-stones with which the flaking was done ; and with these the splintered bones of mammoth and tichorhine rhinoceros, possibly remains of meals. Moreover, as if to point the contrast between the rude palæolithic man who worked these coarse blocks, and apparently never troubled himself to seek for better material, the modern visitor sees within fifty yards of the spot the bottle-shaped pits dug out in later ages by neolithic man through the soil to a depth in the chalk where a layer of good workable flint supplied him with the material for his neat flakes and trimly-chipped arrow-heads. The evidence of caverns such as those of Devonshire and Périgord, with their revelations of early European life and art, has been supplemented by many new explorations, without shaking the conclusion arrived at as to the age known as the reindeer period of the northern half of Europe, when the mammoth and cave-bear and their contemporary mammals had not yet disappeared, but the close of the Glacial period was merging into the times when in England and France savages hunted the reindeer for food as the Arctic tribe of America do still. Human remains of these early periods are still scarce and unsatisfactory for determining race-types. Among the latest finds is part of a skull from the loess at Potbaba, near Prague, with prominent brow-ridges, though less remarkable in this way than the celebrated Neanderthal skull. It remains the prevailing opinion of anatomists that these very ancient skulls are not apt to show extreme lowness of type, but to be higher in the scale than, for instance, the Tasmanian. The evidence increases as to the wide range of palæolithic man. He extended far into Asia, where his characteristic rude stone implements are plentifully found in the caves of Syria and the foot-hills of Madras. The question which this section may have especial means of dealing with is whether man likewise inhabited America with the great extinct animals of the Quaternary period, if not even earlier.

Among the statements brought forward as to this subject, a few are mere fictions, while others, though entirely genuine, are surrounded with doubts, making it difficult to use them for anthropological purposes. We shall not discuss the sandaled human giants, whose foot-prints, twenty inches long, are declared to have been found with the foot-prints of mammoths, among whom they walked, at Carson, Nevada. There is something picturesque in the idea of a man in a past

geological period finding on the Pampas the body of a glyptodon, scooping out its flesh, setting up its carapace on the ground like a monstrous dish-cover, and digging himself a burrow to live in underneath this animal roof; but geologists have not accepted the account. Even in the case of so well-known an explorer as the late Dr. Lund, opinions are still divided as to whether his human skulls from the caves of Brazil are really contemporary with the bones of megatherium and fossil horse. One of the latest judgments has been favorable: Quatrefages not only looks upon the cave-skulls as of high antiquity, but regards their owners as representing the ancestors of the living Indians. The high and narrow dimensions of the ancient and modern skulls are given in the "Crania Ethnica," and, whatever a similarity of proportions between them may prove, it certainly exists. Dr. Koch's celebrated flint arrow-head, recorded to have been found under the leg-bones of a mastodon in Missouri, is still to be seen, and has all the appearance of a modern Indian weapon, which raises doubt of its being really of the mastodon period. This antecedent improbability of remote geological age is felt still more strongly to attach to the stone pestles and mortars, etc., brought forward by Mr. J. D. Whitney, of the California Geological Survey, as found by miners in the gold-bearing gravels. On the one hand, these elaborate articles of stone-work are the very characteristic objects of the Indian graves of the district, and on the other the theory that the auriferous gravels capped by lava-flows are of Tertiary age is absolutely denied by geologists such as M. Jules Marcou in his article on "The Geology of California" ("Bull. Soc. Géol. de France," 1883). It is to be hoped that the section may have the opportunity of discussing Dr. C. C. Abbott's implements from Trenton, New Jersey. The turtle-back celts, as they are called from their flat and convex sides, are rudely chipped from pebbles of the hard argillite out of the bowlder-bed, but the question is as to the position of the sand and gravel in which they are found in the bluffs high above the present Delaware River. The first opinion come to, that the makers of the implements inhabited America not merely after but during the great Ice age, has been modified by further examination, especially by the report of Mr. H. Carvill Lewis, who considers the implement-bearing bed not to have been deposited by a river which flowed over the top of the bowlder-bed, but that, at a later period than this would involve, the Delaware had cut a channel through the bowlder-bed, and that a subsequent glacier-flood threw down sand and gravel in this cutting at a considerable height above the existing river, burying therein the rude stone implements of an Esquimau race then inhabiting the country. Belt, Wilson, and Putnam have written on this question, which I will not pursue further, except by pointing out that the evidence from the bluffs of the Delaware must not be taken by itself, but in connection with that from the terraces high above the James River, near Richmond, where Mr. C. M. Wallace has like-

wise reported the finding of rude stone instruments, to which must be added other finds from Guanajuato, Rio Juchipila, and other Mexican localities.

This leads at once into the interesting argument how far any existing people are the descendants and representatives of man of the post-Glacial period. The problem whether the present Esquimaux are such a remnant of an early race is one which Professor Boyd Dawkins has long worked at, and will, I trust, bring forward with full detail in this appropriate place. Since he stated this view in his work on "Cave-Hunting" it has continually been cited, whether by way of affirmation or denial, but always with that gain to the subject which arises from a theory based on distinct facts. May I take occasion here to mention as preliminary the question, were the natives met with by the Scandinavian seafarers of the eleventh century Esquimaux, and whereabout on the coast were they actually found? It may be to Canadians a curious subject of contemplation how about that time of history Scandinavia stretched out its hands at once to their old and their new home. When the race of bold sea-rovers who ruled Normandy and invaded England turned their prows into the northern and western sea, they passed from Iceland to yet more inclement Greenland, and thence, according to Icelandic records, which are too consistent to be refused belief as to main facts, they sailed some way down the American coast. But where are we to look for the most southerly points which the sagas mention as reached in Vineland? Where was Keel-ness, where Thorvald's ship ran aground, and Cross-ness, where he was buried, when he died by the *skräling's* arrow? Rafn, in the "Antiquitates Americanæ," confidently maps out these places about the promontory of Cape Cod, in Massachusetts, and this has been repeated since from book to book. I must plead guilty to having cited Rafn's map before now, but when with reference to the present meeting I consulted our learned editor of Scandinavian records at Oxford, Mr. Gudbrand Vigfusson, and afterward went through the original passages in the sagas with Mr. York Powell, I am bound to say that the voyages of the Northmen ought to be reduced to more moderate limits. It appears that they crossed from Greenland to Labrador (Helluland), and thence sailing more or less south and west, in two stretches of two days each they came to a place near where wild grapes grew, whence they called the country Vineland. This would, therefore, seem to have been somewhere about the Gulf of St. Lawrence, and it would be an interesting object for a yachting-cruise to try down from the east coast of Labrador a fair four days' sail of a viking-ship, and identify, if possible, the sound between the island and the *ness*, the river running out of the lake into the sea, the long stretches of sand, and the other local features mentioned in the sagas. While this is in the printer's hands, I hear that a paper somewhat to this same effect may come before the Geographical Section, but the matter concerns us here as bearing on the southern

limit of the Esquimaux. The *skrälings* who came on the sea in skin canoes (*hudhkeipr*), and hurled their spears with slings (*valslöngva*), seem by these very facts to have been probably Esquimaux, and the mention of their being swarthy, with great eyes and broad cheeks, agrees tolerably with this. The statement usually made that the word *skräling* meant "dwarf" would, if correct, have settled the question; but, unfortunately, there is no real warrant for this etymology. If we may take it that Esquimaux eight hundred years ago, before they had ever found their way to Greenland, were hunting seals on the coast of Newfoundland, and caribou in the forest, their life need not have been very unlike what it is now in their Arctic home. Some day, perhaps, the St. Lawrence and Newfoundland shores will be searched for relics of Esquimau life, as has been done with such success in the Aleutian Islands by Mr. W. H. Dall, though on this side of the continent we can hardly expect to find, as he does, traces of long residence and rise from a still lower condition.

Surveying now the vast series of so-called native, or indigenous, tribes of North and South America, we may admit that the fundamental notion on which American anthropology has to be treated is its relation to Asiatic. This kind of research is, as we know, quite old, but the recent advances of zoölogy and geology have given it new breadth as well as facility. The theories which account for the wide-lying American tribes, disconnected by language as they are, as all descended from ancestors who came by sea in boats, or across Behring Strait on the ice, may be felt somewhat to strain the probabilities of migration, and are likely to be remodeled under the information now supplied by geology as to the distribution of animals. It has become a familiar fact that the *Equidæ*, or horse-like animals, belong even more remarkably to the New than to the Old World. There was plainly land-connection between America and Asia, for the horses whose remains are fossil in America to have been genetically connected with the horses reintroduced from Europe. The deer may have passed from the Old World into North America in the Pliocene period; and the opinion is strongly held that the camels came the other way, originating in America and spreading thence into Asia and Africa. The mammoth and the reindeer did not cross over a few thousand years ago by Behring Strait, for they had been since Pleistocene times spread over the north of what was then one continent. To realize this ancient land-junction of Asia and America, this "Tertiary bridge," to use Professor Marsh's expression, it is instructive to look at Mr. Wallace's chart of the present soundings, observing that an elevation of under two hundred feet would make Behring Strait land, while moderately shallow sea extends southward to about the line of the Aleutian Islands, below which comes the plunge into the ocean-depths. If, then, we are to consider America as having received its human population by ordinary migration of successive tribes along this high-

way, the importance is obvious of deciding how old man is in America, and how long the continent remained united with Asia, as well as how these two difficult questions are bound up together in their bearing on anthropology. Leaving them to be settled by more competent judges, I will only point out that the theory of northern migration on dry land is, after all, only a revival of an old opinion, which came naturally to Acosta in the sixteenth century, because Behring Strait was not yet known of, and was held by Buffon in the eighteenth because the zoölogical conditions compelled him to suppose that Behring Strait had not always been there. Such a theory, whatever the exact shape it may take, seems wanted for the explanation of that most obvious fact of anthropology, the analogy of the indigenes of America with Asiatics, and more specifically with East and North Asiatics or Mongoloids. This broad race-generalization has thrust itself on every observer, and each has an instance to mention. My own particular instance is derived from inspection of a party of Botocudo Indians lately exhibited in London, who in proper clothing could have passed without question as Thibetans or Siamese. Now, when ethnologists like Dr. Pickering remark on the South Asiatic appearance of Californian tribes, it is open to them to argue that Japanese sailors of junks wrecked on the coast may have founded families there. But the Botocudos are far south and on the other side of the Andes, rude dwellers in the forests of Brazil, and yet they exhibit in an extreme form the Mongoloid character which makes America to the anthropologist part and parcel of Asia. Looked at in this light, there is something suggestive in our still giving to the natives of America the name of Indians; the idea of Columbus that the Caribs were Asiatics was not so absurd, after all.

It is perhaps hardly needful now to protest against stretching the generalization of American uniformity too far, and taking literally Humboldt's saying that he who has seen one American has seen all. The common character of American tribes, from Hudson's Bay to Tierra del Fuego, though more homogeneous than on any other tract of the world of similar extent, admits of wide sub-variation. How to distinguish and measure this sub-variation is a problem in which anthropology has only reached unsatisfactory results. The broad distinctions which are plainly seen are also those which are readily defined, such as the shape of the nose, curve of the lips, or the projection of the cheek-bones. But all who have compared such American races as Aztecs and Ojibways must be sensible of extreme difficulty in measuring the proportions of an average facial type. The attempt to give in a single pair of portraits a generalized national type has been tried —for instance, in the St. Petersburg set of models of races at the Exhibition of 1862. But done merely by eye, as they were, they were not so good as well-chosen individual portraits. It would be most desirable that Mr. Francis Galton's method of photographs, superposed

so as to combine a group of individuals into one generalized portrait, should have a thorough trial on groups of Iroquois, Aztecs, Caribs, and other tribes who are so far homogeneous in feature as to lend themselves to form an abstract portrait. A set of American races thus "Galtonized" (if I may coin the term) would very likely be so distinctive as to be accepted in anthropology. Craniological measurement has been largely applied in America, but unfortunately it was set wrong for years by the same misleading tendency to find a uniformity not really existent. Those who wish to judge Morton's dictum applied to the Scioto mound skull, "the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate," will find facts to the contrary set forth in chapter xx of Wilson's "Prehistoric Man," and in Quatrefages and Hamy, "Crania Ethnica." American crania really differ so much that the hypothesis of successive migrations has been brought in to account for the brachycephalic skulls of the mound-builders as compared with living Indians of the district. Among minor race-divisions, as one of the best established may be mentioned that which in this district brings the Algonquin and Iroquois together into the dolichocephalic division ; yet even here some divide the Algonquins into two groups by their varying breadth of skull. What may be the interpretation of the cranial evidence as bearing on the American problem it would be premature to say ; at present all that can be done is to systematize facts. It is undisputed that the Esquimaux in their complexion, hair, and features approximate to the Mongoloid type of North Asia ; but when it comes to cranial measurement the Esquimaux with their narrower skulls, whose proportion of breadth to length is only seventy-five to eighty, are far from conforming to the broad-skulled type of North Asiatic Mongoloids, whose average index is toward eighty-five. Of this divergence I have no explanation to offer ; it illustrates the difficulties which have to be met by a young and imperfect science.

To clear the obscurity of race-problems, as viewed from the anatomical standing-point, we naturally seek the help of language. Of late years the anthropology of the Old World has had ever-increasing help from comparative philology. In such investigations, when the philologist seeks a connection between the languages of distant regions, he endeavors to establish both a common stock of words and a common grammatical structure. For instance, this most perfect proof of connection has been lately adduced by Mr. R. H. Codrington in support of the view that the Melanesians and Polynesians, much as they differ in skin and hair, speak languages which belong to a common stock. A more adventurous theory is that of Lenormant and Sayce, that the old Chaldean language is connected with the Tartar group ; yet even here there is an *a priori* case based at once on analogies of dictionary and grammar. The comparative method becomes

much weaker when few or no words can be claimed as similar, and the whole burden of proof has to be borne by similar modes of word-formation and syntax, as, for example, in the researches of Aymonier and Keane tending to trace the Malay group of languages into connection with the Khmer or Cambodian. Within America the philologist uses with success the strong method of combined dictionary and grammar in order to define his great language-groups, such as the Algonquin extending from Hudson's Bay to Virginia, the Athapascan from Hudson's Bay to New Mexico, both crossing Canada in their vast range. But attempts to trace analogies between lists of words in Asiatic and American languages, though they may have shown some similarities deserving further inquiry, have hardly proved an amount of correspondence beyond what chance coincidence would be capable of producing. Thus, when it comes to judging of affinities between the great American language-families, or of any of them with the Asiatic, there is only the weaker method of structure to fall back on. Here the Esquimau analogy seems to be with North Asiatic languages. It would be defined as agglutinative-suffixing, or, to put the definition practically, an Esquimau word of however portentous length is treated by looking out in the dictionary the first syllable or two, which will be the root, the rest being a string of modifying suffixes. The Esquimau thus presents in an exaggerated form the characteristic structure of the vast Ural-Altaic or Turanian group of Asiatic languages. In studying American languages as a whole, the first step is to discard the generalization of Duponceau as to the American languages from Greenland to Cape Horn being united together, and distinguished from those of other parts of the world, by a common character of polysynthetism, or combining whole sentences into words. The real divergences of structure in American language-families are brought clearly into view in the two dissertations of M. Lucien Adam, which are the most valuable papers of the Congrès International des Americanistes. Making special examination of sixteen languages of North and South America, Adam considers these to belong to a number of independent or irreducible families, as they would have been, he says, "had there been primitively several human couples." It may be worth suggesting, however, that the task of the philologer is to exhaust every possibility of discovering connections between languages before falling back on the extreme hypothesis of independent origins. These American language-families have grammatical tendencies in common, which suggest original relationship, and in some of these even correspond with languages of other regions in a way which may indicate connection rather than chance. For instance, the distinction of gender, not by sex as male and female, but by life as animate and inanimate, is familiar in the Algonquin group; in Cree *muskesin* = shoe (moccasin) makes its plural *muskesină*, while *eskwayū* = woman (squaw) makes its plural *eskwaywuk*. Now, this kind of gen-

der is not peculiar to America, but appears in Southeast Asia, as for instance in the Kol languages of Bengal. In that Asiatic district also appears the habit of infixing, that is, of modifying roots or words by the insertion of a letter or syllable, somewhat as the Dakota language inserts a pronoun within the verb-root itself, or as that remarkable language, the Choctaw, alters its verbs by insertions of a still more violent character. Again, the distinction between the inclusive and exclusive pronoun *we*, according as it means "you and I" or "they and I," etc. (the want of which is perhaps a defect in English), is as familiar to the Maori as to the Ojibway. Whether the languages of the American tribes be regarded as derived from Asia or as separate developments, their long existence on the American Continent seems unquestionable. Had they been the tongues of tribes come within a short time by Behring Strait, we should have expected them to show clear connection with the tongues of their kindred left behind in Asia, just as the Lapp in Europe, whose ancestors have been separated for thousands of years from the ancestors of the Ostiak or the Turk, still shows in his speech the traces of their remote kinship. The problem how tribes so similar in physical type and culture as the Algonquins, Iroquois, Sioux, and Athapascans, should adjoin one another, yet speaking languages so separate, is only soluble by influences which have had a long period of time to work in.

The comparison of peoples according to their social framework of family and tribe has been assuming more and more importance since it was brought forward by Bachofen, McLennan, and Morgan. One of its broadest distinctions comes into view within the Dominion of Canada. The Esquimaux are patriarchal, the father being head of the family, and descent and inheritance following the male line. But the Indian tribes farther south are largely matriarchal, reckoning descent not on the father's but the mother's side. In fact, it was through becoming an adopted Iroquois that Morgan became aware of this system, so foreign to European ideas, and which he supposed at first to be an isolated peculiarity. No less a person than Herodotus had fallen into the same mistake over two thousand years ago, when he thought the Lykians, in taking their names from their mothers, were unlike all other men. It is now, however, an accepted matter of anthropology, that in Herodotus's time nations of the civilized world had passed through this matriarchal stage, as appears from the survivals of it retained in the midst of their newer patriarchal institutions. For instance, among the Arabs to this day, strongly patriarchal as their society is in most respects, there survives that most matriarchal idea that one's nearest relative is not one's father but one's maternal uncle; he is bound to his sister's children by a "closer and holier tie" than paternity, as Tacitus says of the same conception among the ancient Germans. Obviously great interest attaches to any accounts of existing tribes which preserve for us the explanation of such social phe-

nomena. Some of the most instructive of these are too new to have yet found their way into our treatises on early institutions; they are accounts lately published by Dutch officials among the non-Islamized clans of Sumatra and Java. G. A. Wilken, "Over de Verwantschap en het Huwelijks en Erfrecht bij de Volken van den Indischen Archipel," summarizes the account put on record by Van Hasselt as to the life of the Malays of the Padang Highlands of Mid-Sumatra, who are known to represent an early Malay population. Among these people not only kinship but habitation follows absolutely the female line, so that the numerous dwellers in one great house are all connected by descent from one mother, one generation above another, children, then mothers and maternal uncles and aunts, then grandmothers and maternal great-uncles and great-aunts, etc. There are in each district several *suku* or mother-clans, between persons born in which marriage is forbidden. Here, then, appear the two well-known rules of female descent and exogamy, but now we come into view of the remarkable state of society, that, though marriage exists, it does not form the household. The woman remains in the maternal house she was born in, and the man remains in his; his position is that of an authorized visitor; if he will, he may come over and help her in the rice-field, but he need not; over the children he has no control whatever, and were he to presume to order or chastise them, their natural guardian, the mother's brother (*mamak*), would resent it as an affront. The law of female descent and its connected rules have as yet been mostly studied among the native Americans and Australians, where they have evidently undergone much modification. Thus, one hundred and fifty years ago, Father Lafitau mentions that the husband and wife, while in fact moving into one another's hut, or setting up a new one, still kept up the matriarchal idea by the fiction that neither he nor she quitted their own maternal house. But in the Sumatra district just referred to, the matriarchal system may still be seen in actual existence, in a most extreme and probably early form. If, led by such new evidence, we look at the map of the world from this point of view, there discloses itself a remarkable fact of social geography. It is seen that matriarchal exogamous society, that is, society with female descent and prohibition of marriage within the clan, does not crop up here and there, as if it were an isolated invention, but characterizes a whole vast region of the world. If the Malay district be taken as a center, the system of intermarrying mother-clans may be followed westward into Asia, among the Garos and other hill tribes of India. Eastward from the Indian Archipelago it pervades the Melanesian Islands, with remains in Polynesia; it prevails widely in Australia, and stretches north and south in the Americas. This immense district represents an area of lower culture, where matriarchalism has only in places yielded to the patriarchal system, which develops with the idea of property, and which, in the other and more civilized half of the

globe, has carried all before it, only showing in isolated spots and by relics of custom the former existence of matriarchal society. Such a geographical view of the matriarchal region makes intelligible facts which, while not thus seen together, were most puzzling. When years ago Sir George Grey studied the customs of the Australians, it seemed to him a singular coincidence that a man whose maternal family name was Kangaroo might not marry a woman of the same name, just as if he had been a Huron of the Bear or Turtle totem, prohibited accordingly from taking a wife of the same. But when we have the facts more completely before us, Australia and Canada are seen to be only the far ends of a world-district pervaded by these ideas, and the problem becomes such a one as naturalists are quite accustomed to. Though Montreal and Melbourne are far apart, it may be that in prehistoric times they were both connected with Asia by lines of social institution as real as those which in modern times connect them through Europe. Though it is only of late that this problem of ancient society has received the attention it deserves, it is but fair to mention how long ago its scientific study began in the part of the world where we are assembled. Father Lafitau, whose "Mœurs des Sauvages Amériquains" was published in 1724, carefully describes among the Iroquois and Hurons the system of kinship to which Morgan has since given the name of "classificatory," where the mother's sisters are reckoned as mothers, and so on. It is remarkable to find this acute Jesuit missionary already pointing out how the idea of the husband being an intruder in his wife's house bears on the pretense of surreptitiousness in marriage among the Spartans. He even rationally interprets in this way a custom which to us seems fantastic, but which is a most serious observance among rude tribes widely spread over the world. A usual form of this custom is that the husband and his parents-in-law, especially his mother-in-law, consider it shameful to speak to or look at one another, hiding themselves or getting out of the way, at least in pretense, if they meet. The comic absurdity of these scenes, such as Tanner describes among the Assiniboins, disappears if they are to be understood as a legal ceremony, implying that the husband has nothing to do with his wife's family. To this part of the world also belongs a word which has been more effective than any treatise in bringing the matriarchal system of society into notice. This is the term *totem*, introduced by Schoolcraft to describe the mother-clans of the Algonquins, named "Wolf," "Bear," etc. Unluckily the word is wrongly made. Professor Max Müller has lately called attention to the remark of the Canadian philologist, Father Cuoq ("N. O. Ancien Missionnaire"), that the word is properly *ote*, meaning "family mark," possessive *otem*, and with the personal pronoun *nind otem*, "my family mark," *kit otem*, "thy family mark." It may be seen, in Schoolcraft's own sketch of Algonquin grammar, how he erroneously made from these a word *totem*, and the question ought perhaps to be gone into in this

section, whether the term had best be kept up or amended, or a new term substituted. It is quite worth while to discuss the name, considering what an important question of anthropology is involved in the institution it expresses. In this region there were found Iroquois, Algonquins, Dakotas, separate in language, and yet whose social life was regulated by the matriarchal totem structure. May it not be inferred from such a state of things, that social institutions form a deeper-lying element in man than language or even physical race-type? This is a problem which presents itself for serious discussion, when the evidence can be brought more completely together.

It is obvious that, in this speculation, as in other problems now presenting themselves in anthropology, the question of the antiquity of man lies at the basis. Of late no great progress has been made toward fixing a scale of calculation of the human period, but the arguments as to time required for alterations in valley-levels, changes of fauna, evolution of races, languages, and culture, seem to converge more conclusively than ever toward a human period short indeed as a fraction of geological time, but long as compared with historical or chronological time. While, however, it is felt that length of time need not debar the anthropologists from hypotheses of development and migration, there is more caution as to assumptions of millions of years where no arithmetical basis exists, and less tendency to treat everything prehistoric as necessarily of extreme antiquity, such as, for instance, the Swiss lake-dwelling and the Central American temples. There are certain problems of American anthropology which are not the less interesting for involving no considerations of high antiquity; indeed, they have the advantage of being within the check of history, though not themselves belonging to it.

Humboldt's argument as to traces of Asiatic influence in Mexico is one of these. The four ages in the Aztec picture-writings, ending with catastrophes of the four elements, earth, fire, air, water, compared by him with the same scheme among the Banyans of Surat, is a strong piece of evidence which would become yet stronger if the Hindoo book could be found from which the account is declared to have been taken. Not less cogent is his comparison of the zodiacs or calendar-cycles of Mexico and Central America with those of Eastern Asia, such as that by which the Japanese reckon the sixty-year cycle by combining the elements *seriatim* with the twelve animals, Mouse, Bull, Tiger, Hare, etc.; the present year is, I suppose, the second water-ape year, and the time of day is the goat-hour. Humboldt's case may be re-enforced by the consideration of the magical employment of these zodiacs in the Old and New World. The description of a Mexican astrologer, sent for to make the arrangements for a marriage by comparing the zodiac animals of the birthdays of bride and bridegroom, might have been written almost exactly of the modern Calmucks; and in fact it seems connected in origin with similar rules in our own books of astrology.

Magic is of great value in thus tracing communication, direct or indirect, between distant nations. The power of lasting and traveling which it possesses may be instanced by the rock-pictures from the sacred Roches Percées of Manitoba, sketched by Dr. Dawson, and published in his father's volume on "Fossil Man," with the proper caution that the pictures, or some of them, may be modern. Besides the rude pictures of deer and Indians and their huts, one sees with surprise a pentagram more neatly drawn than that defective one which let Mephistopheles pass Faust's threshold, though it kept the demon in when he had got there. Whether the Indians of Manitoba learned the magic figure from the white man, or whether the white man did it himself in jest, it proves a line of intercourse stretching back twenty-five hundred years to the time when it was first drawn as a geometrical diagram of the school of Pythagoras. To return to Humboldt's argument, if there was communication from Asia to Mexico before the Spanish Conquest, it ought to have brought other things, and no things travel more easily than games. I noticed some years ago that the Aztecs are described by the old Spanish writers as playing a game called *patolli*, where they moved stones on the squares of a cross-shaped mat, according to the throws of beans marked on one side. The description minutely corresponds with the Hindoo game of *pachisi*, played in like manner with cowries instead of beans; this game, which is an early variety of backgammon, is well known in Asia, whence it seems to have found its way into America. From Mexico it passed into Sonora and Zacatecas, much broken down but retaining its name, and it may be traced still further into the game of plum-stones among the Iroquois and other tribes. Now, if the probability be granted that these various American notions came from Asia, their importation would not have to do with any remotely ancient connection between the two continents. The Hindoo element-catastrophes, the East Asiatic zodiac-calendars, the game of backgammon, seem none of them extremely old, and it may not be a thousand years since they reached America. These are cases in which we may reasonably suppose communication by seafarers, perhaps even in some of those junks which are brought across so often by the ocean-current and wrecked on the California coast. In connection with ideas borrowed from Asia there arises the question, How did the Mexicans and Peruvians become possessed of bronze? Seeing how imperfectly it had established itself, not even dispossessing the stone implements, I have long believed it to be an Asiatic importation of no great antiquity, and it is with great satisfaction that I find such an authority on prehistoric archæology as Professor Worsaae comparing the bronze implements in China and Japan with those of Mexico and Peru, and declaring emphatically his opinion that bronze was a modern novelty introduced into America. While these items of Asiatic culture in America are so localized as to agree best with the hypothesis of communication far south across the

Pacific, there are others which agree best with the routes far north. A remarkable piece of evidence pointed out by General Pitt-Rivers is the geographical distribution of the Tartar or composite bow, which in construction is unlike the long-bow, being made of several pieces spliced together, and which is bent backward to string it. This distinctly Asiatic form may be followed across the region of Behring Strait into America among the Esquimaux and northern Indians, so that it can hardly be doubted that its coming into America was by a northern line of migration. This important movement in culture may have taken place in remotely ancient times.

A brief account may now be given of the present state of information as to movements of civilization within the double continent of America. Conspicuous among these is what may be called the northward drift of civilization, which comes well into view in the evidence of botanists as to cultivated plants. Maize, though allied to, and probably genetically connected with, an Old World graminaceous family, is distinctly American, and is believed by De Candolle to have been brought into cultivation in Peru, whence it was carried from tribe to tribe up into the North. To see how closely the two continents are connected in civilization, one need only look at the distribution on both of maize, tobacco, and cacao. It is admitted as probable that from the Mexican and Central American region agriculture traveled northward, and became established among the native tribes. This direction may be clearly traced in a sketch of their agriculture, such as is given in Mr. Lucien Carr's paper on the "Mounds of the Mississippi Valley." The same staple cultivation passed on from place to place—maize, haricots, pumpkins, for food, and tobacco for luxury. Agriculture among the Indians of the Great Lakes is plainly seen to have been an imported craft by the way in which it had spread to some tribes but not to others. The distribution of the potter's art is similarly partial, some tribes making good earthen vessels, while others still boiled meat in its own skin with hot stones, so that it may well be supposed that the arts of growing corn and making the earthen pot to boil the hominy came together from the more civilized nations of the south. With this northward drift of civilization other facts harmonize. The researches of Buschmann, published by the Berlin Academy, show how Aztec words have become imbedded in the languages of Sonora, New Mexico, and up the western side of the continent, which could not have spread there without Mexican intercourse extending far northwest. This, indeed, has left many traces still discernible in the industrial and decorative arts of the Pueblo Indians. Along the courses of this northward drift of culture remain two remarkable series of structures probably connected with it. The *casas grandes*, the fortified communal barracks (if I may so call them) which provided house-room for hundreds of families, excited the astonishment of the early Spanish explorers, but are only beginning to be thoroughly described now that

such districts as the Taos Valley have come within reach by the railroads across to the Pacific. The accounts of these village-forts and their inhabitants, drawn up by Major J. W. Powell, of the Bureau of Ethnology, and Mr. Putnam, of the Peabody Museum, disclose the old communistic society surviving in modern times, in instructive comment on the philosophers who are seeking to return to it. It would be premature in the present state of information to decide whether Mr. J. L. Morgan, in his work on the "Houses and House-Life of the American Aborigines," has realized the conditions of the problem. It is plausible to suppose with him a connection between the communal dwellings of the American Indians, such as the Iroquois long-house with its many family hearths, with the more solid buildings inhabited on a similar social principle by tribes such as the Zuñis of New Mexico. Morgan was so much a man of genius, that his speculations, even when at variance with the general view of the facts, are always suggestive. This is the case with his attempt to account for the organization of the Aztec state as a highly developed Indian tribal community, and even to explain the many-roomed stone palaces, as they are called, of Central America, as being huge communal dwellings like those of the Pueblo Indians. I will not go further into the subject here, hoping that it may be debated in the section by those far better acquainted with the evidence. I need not, for the same reason, do much more than mention the mound-builders, nor enter largely on the literature which has grown up about them since the publication of the works of Squier and Davis. Now that the idea of their being a separate race of high antiquity has died out, and their earthworks, with the implements and ornaments found among them, are brought into comparison with those of other tribes of the country, they have settled into representatives of one of the most notable stages of the northward drift of culture among the indigenes of America.

Concluding this long survey, we come to the practical question how the stimulus of the present meeting may be used to promote anthropology in Canada. It is not as if the work were new here; indeed, some of its best evidence has been gathered on this ground from the days of the French missionaries of the seventeenth century. Naturally, in this part of the country, the rudimentary stages of thought then to be found among the Indians have mostly disappeared. For instance, in the native conceptions of souls and spirits the crudest animistic ideas were in full force. Dreams were looked on as real events, and the phantom of a living or a dead man seen in a dream was considered to be that man's personality and life, that is, his soul. Beyond this, by logical extension of the same train of thought, every animal or plant or object, inasmuch as its phantom could be seen away from its material body in dreams or visions, was held to have a soul. No one ever found this primitive conception in more perfect form than Father Lallemant, who describes, in the "Rélations des Jesuites"

(1626), how, when the Indians buried kettles and furs with the dead, the bodies of these things remained, but the souls of them went to the dead men who used them. So Father Le Jeune describes the souls, not only of men and animals, but of hatchets and kettles, crossing the water to the Great Village out in the sunset. The genuineness of this idea of object-souls is proved by other independent explorers finding them elsewhere in the world. Two of the accounts most closely tallying with the American come from the Rev. Dr. Mason, in Burmah, and the Rev. J. Williams, in Feejee. That is to say, the most characteristic development of early animism belongs to the same region as the most characteristic development of matriarchal society, extending from Southeast Asia into Melanesia and Polynesia, and North and South America. Every one who studies the history of human thought must see the value of such facts as these, and the importance of gathering them up among the rude tribes who preserve them, before they pass into a new stage of culture. All who have read Mr. Hale's studies on the Hiawatha legend and other Indian folk-lore must admit that the native traditions, with their fragments of real history, and their incidental touches of native religion, ought never to be left to die out unrecorded. In the Dominion, especially in its outlying districts toward the Arctic region and over the Rocky Mountains, there is an enormous mass of anthropological material of high value to be collected ; but this collection must be done within the next generation, or there will be little left to collect. The small group of Canadian anthropologists, able and energetic as they are, can manage and control this work, but can not do it all themselves. What is wanted is a Canadian Anthropological Society with a stronger organization than yet exists, able to arrange explorations in promising districts, to circulate questions and requirements among the proper people in the proper places, and to lay a new burden on the shoulders of the already hard-worked professional men, and other educated settlers through the newly opened country, by making them investigators of local anthropology. The Canadian Government, which has well deserved the high reputation it holds throughout the world for wisdom and liberality in dealing with the native tribes, may reasonably be asked to support more thorough exploration, and collection and publication of the results, in friendly rivalry with the United States Government, which has in this way fully acknowledged the obligation of making the colonization of new lands not only promotive of national wealth, but serviceable to science. It is not for me to do more here, and now, than to suggest practical steps toward this end. My laying before the section so diffusive a sketch of the problems of anthropology, as they present themselves in the Dominion, has been with the underlying intention of calling public notice to the important scientific work now standing ready to Canadian hands ; the undertaking of which, it is to be hoped, will be one outcome of this visit of the British Association to Montreal.

SCHOOL-CULTURE OF THE OBSERVING FACULTIES.*

By J. C. GLASHAW.

WHY should children be sent to school? Is it merely that they may learn to read, to write, and cipher? Reading, writing, and ciphering are no doubt very important, but are they all-important, or even most important? The man who reads may be said to hear from the past and the distant; the man who writes speaks to the future and the far away. Reading and writing are indeed important, for they enable us to converse untrammeled by the shackles of time and space. But the man who reads learns only what others already know, and he learns it, mayhap, not even as they know it, but only as they express their knowledge, and as he understands that expression. He looks at things through other men's spectacles, without knowing whether those spectacles magnify, minify, color, or distort. Surely more important than learning and blindly accepting the opinions of other men is it to be able to form opinions for one's self, and at the same time to know that these opinions have been properly arrived at and are correct.

If a boy is to be a carpenter, it is all very well for him to read about the different kinds of wood he will have to work upon, and about the various tools employed in his future trade, but he will learn to use these tools only by using them; he will learn to distinguish the different kinds of wood, and to select the kind and the piece suitable for his purpose in each case, only by actual practice of his trade. And what is true of the carpenter is true, *mutatis mutandis*, of every other handicraft, of every business, of every profession. However much one may learn by reading, it is but little and unimportant compared to what must be learned by actual practice. But even if we desired it we can not, during the short time our pupils are at school, exercise them in all the trades and professions. What, then, can we do? We can so teach them that this practice, when it must begin, will not be set about in a blind, hap-hazard way. We can and we ought to teach our pupils HOW TO LEARN; we can train them and we ought to train them to observe and to use the results of their observation.

But, the handicraft, the business, or the profession once learned, is the boy, now grown a man, done with observation? By no means. Every time he is called upon to make application of the knowledge he possesses, the skill he has acquired, he must observe, draw inferences, and reason therefrom; and his success in his calling will depend on the accuracy with which he does all this. Reading will supply him with other men's observations and reasonings, but these will be useless

* Read before the Ottawa Teachers' Association.

for the case in hand, unless they were made under like circumstances, or unless they can be modified to suit the present conditions. Now, to judge what are the real circumstances and conditions of the case, the man must be able to observe these conditions, and to distinguish those that are essential from those that are merely accidental, to interpret his observations aright, and then to reason correctly from the results thus obtained.

But man does not exist wholly and solely to carry on some handicraft, business, or profession. Around him lies a world abounding with endless sources of health and happiness, if only he knows where to look for them and how to use them, but equally abounding with pitfalls of misery and distress to all who grope through life intellectually blind and deaf, who having eyes see not, and having ears hear not. Now, the securing of that health and happiness of which I have spoken, so far as it depends on the material world around a man, will depend on his ability to observe closely, to systematize his observations into related groups, and to connect these with the observations and experiences of other men, so as to obtain therefrom a living knowledge of the laws of his being and of the world around him. Here, again, power of observation is the first and most important requisite, and, as a natural gift or talent, this power is extremely rare; "for the observer," as John Stuart Mill has remarked, "is not he who merely sees the thing which is before his eyes, but he who sees what parts that thing is composed of. One person, from inattention or from attending only in the wrong place, overlooks half of what he sees; another sets down much more than he sees, confounding it with what he imagines, or with what he infers; another takes note of the *kind* of all the circumstances, but, being inexpert in estimating their degree, leaves the quantity of each vague and uncertain; another sees indeed the whole, but makes such an awkward division of it into parts, throwing things into one mass which require to be separated, and separating others which might more conveniently be considered as one, that the result is much the same as, sometimes even worse than, if no analysis had been attempted at all."

But if man does not exist solely for his profession, neither does he exist solely for and unto himself. He is under certain obligations to his family and to his fellow-men, he has domestic and social duties, and to fulfill these aright, amid the ever-shifting conditions of life, requires the keenest powers of observation, of interpretation, and of judgment. And although destruction as surely awaits the man who dwells in moral darkness as it does him who takes his way heedless of all the physical laws of his being, too often the evil he does dies not with him, but lives and works woe to those he loved and would fain have protected. Yet it is here, it is in what regards their social life (and under social I include domestic and political), that too many men seem to be unable to observe aright or to make any use of such ob-

servations as they may have correctly made. When their course is not taken at utter random, too often it is guided by blind empiricism, or else is only a prolonged game of "follow your leader." The boy was not trained to observe and to think for himself when the subjects he had to examine and to think about were comparatively simple, and now the grown man will not or can not do it, or, if he does actually try, he is as likely to go astray as to go right, for he now must begin on what is extremely complex.

If, then, our school instruction aims at preparing pupils for the duties of after-life, however important we may deem those forms of hearing and speaking which we call reading and writing, even more important ought we to consider observation and inference and reasoning therefrom. That man is best equipped for the mental work which is more or less the business of every one from the cradle to the grave, who is able to use all his senses aright, who best knows all the precautions that must be taken to guard against misinterpreting the evidence of those senses, and against wrong reasoning from that evidence; who best knows how to trace thought backward to the grounds of belief and forward to discovery and verification. That is the best education that fosters the mother of freedom — independence of thought.

I have spoken of the insufficiency of reading and writing as a means of education, because there are still among us some who declare that these arts, with a little knowledge of ciphering, are all that should be taught in our public schools, are all the education that should be given to the children of the people; all the training for the battle of life, for the "struggle for existence," that should be provided for those who will have to bear the brunt of that battle, who will have to wage the fiercest contests in that strife. By all means, teach the children to read, teach them to write, teach them to cipher, but also train them in those mental processes which all men have to employ somehow or other every hour of their waking life, in every transaction of their daily business. Train them to do well and to know that they are doing well what they must do if they are to live at all.

But how is a child to be trained in these mental processes? In exactly the same way that he is trained in any art, in any handicraft. A man learns to play on the violin by playing on the violin, and no amount of directions without actual practice will make him proficient. So a child must be taught to observe by observing, to draw inferences by inferring, and to reason correctly by reasoning correctly; but if he is to do these things well he must practice them at first under the guidance of a master in these arts, and must have before him models of perfection in them. Now, Science presents us with the very best examples of accurate and discriminative observation, and of inference therefrom; it begins with the study of the very simplest phenomena, and advances its investigations step by step to a complete and exhaust-

ive analysis of the most complicated actions and relations. It is pre-eminently the study in which one is trained in the *whole* art of thinking, and in which one is taught to be conscious of each step he takes in the onward march of his investigations, and to know that the course he is following, and that course alone, will lead him to the truth, the arriving at which is the ultimate object of all his labors.

But here I must utter a word of warning. It is of the utmost importance to distinguish clearly between *scientific information* and *training in science*, between a mere literary acquaintance with scientific facts such as may be attained by a reader possessed of a somewhat acute mind and a fair share of constructive imagination and that power, those habits of mind, which are only to be gained by the study of facts at first hand. To the majority of pupils, it would not be the information they would gain by a study of science, valuable though this would be, that would be of chief importance, but the scientific habit of mind they would acquire. This habit would be of incalculable benefit to them whatever might be their avocations in after-life, and it would be better attained by a thorough investigation of the facts and principles of one science than by a general acquaintance with what has been spoken or written about many of them.

That this warning against confusing information and training is not wholly unnecessary will be seen by the following extract from the late Professor Todhunter's essay, entitled "The Conflict of Studies":

"We assert," says the professor, "that, if the resistance of the air be withdrawn, a sovereign and a feather will fall through equal spaces in equal times. Very great credit is due to the person who first imagined the well-known experiment to illustrate this, but it is not obvious what is the special benefit now gained by seeing a lecturer repeat the process. It may be said that a boy takes more interest in the matter by seeing for himself, or by performing for himself, that is, by working the handle of the air-pump; this we admit, while we continue to doubt the educational value of the transaction. The boy would also take much more interest in foot-ball than in Latin grammar, but the measure of his interest is not identical with that of the importance of the subjects. It may be said that the fact makes a stronger impression on the boy through the medium of his sight, that he believes it more confidently. I say that this ought not to be the case. If he does not believe the statement of his tutor—probably a clergyman of mature knowledge, recognized ability, and blameless character—his suspicion is irrational, and manifests a want of the power of appreciating evidence, a want fatal to his success in that branch of science which he is supposed to be cultivating."

Professor Todhunter was an eminent teacher of mathematics; he wrote many text-books on this science, some of which have been translated into nearly every civilized tongue, he even wrote an elementary text-book on physical science, the very science the boy is here as-

sumed to be studying, yet in the above paragraph he presents us with an argument which would be amusing had it come from the pen of a mere literary man, but which it is almost impossible to believe a cultivator of science could advance in sober earnest. What would have been the thoughts and feelings of the professor had one of his pupils, when asked to demonstrate the *pons asinorum*, returned answer:

"Sir, my tutor was the Rev. Mr. Jones, of Westbury; he is a clergyman of mature knowledge, recognized ability, and blameless character. Now, he assured me that he had examined Euclid's proof of this proposition, and had found it to be correct, and as to doubt his word would be to manifest irrational suspicion, and a want of power to properly appreciate evidence, I accepted his testimony, and I now offer it to you as my proof."

I suspect that that pupil's ideas of proof would have received a clearing up. He would have learned that there are other kinds of evidence besides oral testimony, and that it is as necessary to be able to judge of the validity in each case, of these other kinds of evidence, as it is to be able to judge of the value of testimony. He would learn that, unless he were to be a professed mathematician, a knowledge of the bare truth of the *pons asinorum* was a matter of no moment, the important thing was to see how that truth was arrived at, and how it was demonstrated; the educative factor present in the study was the exercise of the reasoning faculties, and of the powers of orderly arranging and of clearly presenting all the parts of a somewhat long argument.

So in the experiment with the sovereign and the feather, the mere testing of the truth or the falsehood of the statement that, if the resistance of the air be got rid of, a feather will fall earthward as fast as a sovereign, is not the chief thing aimed at. In fact, this statement should not be advanced prior to the performance of the experiment, but the fact stated in it should be discovered by the pupils for themselves from the experiment; and I beg to add that, had Professor Todhunter ever actually tried the experiment with the common apparatus, he would possibly have found the discovery of the fact not quite so simple a matter for a boy as he evidently imagined it to be.

But Professor Todhunter, while admitting that a boy takes more interest in seeing an experiment performed or in performing it for himself than in merely hearing a statement of its truth, doubts the educational value of the appeal to the senses. Any teacher of natural science worthy of the name of teacher would from his experience be able instantly to explain why this increase of interest, and instantly to set all doubts regarding the matter to rest. *There seems in many minds to be an almost total separation between words and the things they represent, except as regards constantly recurring incidents of their daily life.* Hence words seem to have no power in such cases to call

up and keep before the mental vision a distinct image of the thing reasoned about. In fact, what is called the scientific imagination seems almost wanting in many minds until a severe course of training in science arouses the dormant faculty, and develops into the actual and the active what otherwise would have remained an unnoticed and neglected potentiality. The consequence is, that the teacher who depends on verbal statements alone can never be sure that the ideas so clear to himself are correct, if at all apprehended by his pupils, and that these are not increasing their ignorance rather than their knowledge. Many minds which seem to become sluggish, or to wither away when fed with what to them are the dry husks of words, are roused to activity and intelligence when they are directed to the study of things and the relations of things, when they are brought face to face, so to speak, with the actual phenomena of the world around and within them.

But before I pass from this let me point out that the guinea-and-feather experiment, if *successfully* performed, is about as bad an example of an educative experiment as could well be selected. The bare fact to be observed would stand out too distinctly, too completely disentangled from other phenomena to give it any value in training the observing faculties of any but mere infants, while the inferences and deductions from the results of the experiment are too abstruse for any but those who have advanced some way in quantitative analysis of phenomena. Moreover, the mere experimental result can be obtained without any elaborate apparatus, while the deduced propositions can be, and in actual practice generally are, arrived at by simpler means. In truth, the experiment is not one which should be presented to the pupil in order to deduce from it that the earth's attraction depends, not on the nature of a body, but merely on its mass, but he should be skillfully led to suggest this experiment as a test of the truth of this proposition. In fact, it is an experiment of *verification*, not an experiment of *discovery*.

It was my intention, when I consented to address you on this subject, to present you with an outline of how actually to proceed in order to give children a systematic training in observation, selecting plants as the objects for examination. Botany has been called a science of mere names, and it must be confessed it has too often been presented as such ; but, rightly treated, it offers a wide field and ample scope for observation of the forms, the positions, and the functions of the various parts of plants, of the relations of these parts to each other, and of their modifications and adaptations to varying conditions, as well as for many other observations just such as children in our primary classes are capable of making. But all, and more than all, I purposed doing, has been done and so well done by Miss Eliza A. Youmans, in her "First Book of Botany," that I believe it will be better to refer you direct to that work, rather than to enter on details here. If one

of you will take, say, a second class through the first twenty exercises in Miss Youmans's little book, working them out conscientiously and thoroughly, I do not hesitate to predict that that class will by this means acquire more real knowledge and more intellectual power than it would acquire from all the reading, writing, and ciphering done in the first four classes, if done without such a course. Furthermore, the power gained and the habits acquired in the study of plants, or even in the examination of leaves, will not be confined solely to these, but will be directed to and exercised upon all other objects coming within the range of the children's observation; thus their general knowledge will be extended, and, as a result, your pupils will read with more intelligence and with fuller comprehension of what they are reading about. As for arithmetic—and here I can speak with some authority—you will find that you have somehow bridged over the to many seemingly impassable gulf between the mere art of ciphering and the application of that art to the resolution of numerical problems. Words will no longer be mere vacant forms or empty sounds, their content will be restored to them, the data of the problem will be mentally *realized*, and their interrelations discovered and comprehended. In nine cases out of ten, it is the inability to realize the data, to project before the mind's eye a picture of the reality, that is the actual stumbling-block in the way of children who fail in the solution of arithmetical problems.

But the work had better not be done at all if it be not done *thoroughly* and *conscientiously*. All that can be done in a text-book is merely to set up numerous finger-posts to guide the student or the teacher; the scenery on the route can not be presented in all its fullness of detail, with all its play of light and shade; to behold it one must actually travel the road. In the course of teaching these twenty exercises, thousands of questions will arise of whys and wherefores, some of which you will have to put aside for the time being at least; but to others you must lead your children to find the answers for themselves. All these questions can not possibly be anticipated in any book; and it is well they can not be so, for, ever new, ever changing, they afford mental exercise to the teacher as well as to the pupils, and thus prevent any danger of stagnation on either side. Let me take in illustration a very simple question; one interesting to myself personally, because it was the first botanical problem I ever solved, but which, if the solution be properly generalized, is interesting in itself as giving the key to many peculiarities in the forms and markings of leaves.

When I was but a lad at school, a fellow-pupil, the son of a farmer, told me that on the back of every green blade of oats there was legibly stamped a capital B. I laughed at him for his simplicity in thinking he could make me believe such an "old wife's fable"; but he indignantly replied that not only had his father told him of

the strange marking, but he had looked and seen it for himself. The only way, it seemed to me, to treat such an argument as this was, to change the subject of conversation, and this I did, a slight smile of incredulity letting my playmate know that he had not wholly imposed upon me. That very afternoon I happened to pass a field of oats, and, remembering the assertion of the mysterious markings, I determined to put the question of their reality to the proof of observation at once, and for altogether. I must confess, however, it was only after a mental struggle that I brought myself to cross the fence into the field; for the assertion seemed to me utterly absurd, and I had not then learned that, rightly taken, there is no such thing as "being made a fool of." But what were my amazement and confusion to find, on the very first leaf I examined, a capital B as clearly marked as if it had been impressed with a die! Quickly gathering and examining other leaves, I found on all of them a marking, in some a mere blur, on others clear and distinct as I had found it on the first leaf. Straightway occurred the questions: What really is this mark? What causes it? I stood among the growing oats, so the answer was neither far to seek nor difficult to find; but I have never forgotten it, for no teacher told it to me—I found it out for myself. I rediscovered the solution of the mystery of this leaf-signature, and, although it must have been discovered and rediscovered thousands of times before, yet I enjoyed all the deep delight of discovery—a delight which never cloys, a pleasure which never palls. What is more, I soon found that my eyes had, as it were, been opened; I found that I could see many other strange things about leaves which, till then, had escaped my notice, and I found that I possessed the key to their solution.

But, if I urge on you the teaching of natural science, I also recognize the difficulties you will encounter if you accept my advice. You will have to teach from the actual objects, a method utterly and radically different from the text-book instruction to which you are accustomed. You will for a time have to submit to the adverse criticisms of those parents who judge of a child's progress, not by its mental growth, but merely by its increase of skill in the art of recognizing the marks that represent certain sounds, and of repeating those sounds, an art too often confused with reading. You will, some of you, have to struggle with classes not too large to inform by telling but far too large to educate by training. But overcome the first difficulty, overcome yourselves, and you will find the others will lessen day by day, and will soon disappear altogether, the little remaining of them being lost sight of in the increase of brightness which the new study will bring to the life of the school-room.

QUEER FLOWERS.

By GRANT ALLEN.

IF Baron Munchausen had ever in the course of his travels come across a single flower one standard British yard in diameter, fifteen pounds avoirdupois in weight, and forming a cup big enough to hold six quarts of water in its central hollow, it is not improbable that the learned baron's veracious account of the new plant might have been met with the same polite incredulity which his other adventures shared with those of Bruce, Stanley, Mendez Pinto, and Du Chaillu. Nevertheless, a big blossom of this enormous size has been well known to botanists ever since the beginning of the present century. When Sir Stamford Raffles was taking care of Sumatra during our temporary annexation, he happened one day to light upon a gigantic parasite, which grew on the stem of a prostrate creeper in the densest part of the tropical jungle. It measured nine feet round and three feet across ; it had five large, fleshy petals with a central basin ; and it was mottled red in hue, being, in fact, in color and texture surprisingly suggestive of raw beefsteak. One flower was open when Sir Stamford came upon it ; the other was in the bud, and looked in that state extremely like a very big red cabbage. Specimens of this surprising find were at once forwarded to England (how, history does not inform us) ; and, after the place of the plant in the classificatory system had been strenuously fought out with the usual scientific amenities, it was at last duly labeled (through no fault of its own), after the names of its two discoverers, as *Rafflesia Arnoldi.*

The mere size of this mammoth among flowers would in itself naturally suffice to give it a distinct claim to respectful attention ; but Rafflesia possesses many other sterling qualities far more calculated than simple bigness to endear it to a large and varied circle of insect acquaintances. The oddest thing about it, indeed, is the fact that it is a deliberately deceptive and alluring blossom. As soon as it was first discovered, Dr. Arnold noticed that it possessed a very curious carrion-smell, exactly like that of putrefying meat. He also observed that this smell attracted flies in large numbers by false pretenses to settle in the center of the cup. But it is only of late years that the real significance and connection of these curious facts have come to be perceived. We now know that Rafflesia is a flower which wickedly and feloniously lays itself out to deceive the confiding meat-flies and to starve their helpless infants in the midst of apparent plenty. The majority of legitimate flowers (if I may be allowed the expression) get themselves decently fertilized by bees and butterflies, who may be considered as representing the regular trade, and who carry the fecundating pollen on their heads and proboscises from one blossom to an-

other, while engaged in their usual business of gathering honey all the day from every opening flower. But Rafflesia, on the contrary, has positively acquired a fallacious external resemblance to raw meat, and a decidedly high flavor, on purpose to take in the too trustful Sumatran flies. When a fly sights and scents one, he (or rather she) proceeds at once to settle in the cup, and there lay a number of eggs in what it naturally regards as a very fine decaying carcass. Then, having dusted itself over in the process with plenty of pollen from this first flower, it flies away confidingly to the next promising bud, in search both of food for itself and of a fitting nursery for its future little ones. In doing so, it of course fertilizes all the blossoms that it visits, one after another, by dusting them successively with one another's pollen. When the young grubs are hatched out, however, they discover the base deception all too late, and perish miserably in their fallacious bed, the helpless victims of misplaced parental confidence. Even as Zeuxis deceived the very birds with his painted grapes, so Rafflesia deceives the flies themselves by its ingenious mimicry of a putrid beefsteak. In the fierce competition of tropical life, it has found out by simple experience that dishonesty is the best policy.

The general principle which this strange flower illustrates in so striking a fashion is just this: Most common flowers have laid themselves out to attract bees, and so a bee-flower forms our human ideal of a central typical blossom: it looks, in short, we think, as a flower ought to look. But there are some originally minded and eccentric plants which have struck out a line for themselves, and taken to attracting sundry casual flies, wasps, midges, beetles, snails, or even birds, which take the place of bees as their regular fertilizers; and it is these Bohemians of the vegetable world that make up what we all consider as the queerest and most singular of all flowers. They adapt their appearance and structure to the particular tastes and habits of their chosen guests.

Now, the fact is, we are all a little tired of that prig and Aristides among insects, the little busy bee. We have heard his virtues praised by poets, moralists, and men of science, till we are all burning to ostracize him forthwith, for the sake of never more hearing him called industrious and intelligent. He and his self-righteous cousin, the ant, are in fact a pair of egregious Pharisaical humbugs, who have made a virtue of their own excessive acquisitiveness, and have induced Solomon, Virgil, Dr. Watts, and other misguided human beings to acquiesce far too readily in their preposterous claims. For my own part, I never was more pleased in my life than when Sir John Lubbock conclusively proved by experiment that they were both extremely stupid and uninventive insects, with scarcely a faint glimmering of brotherly love or any other good ethical quality. I propose, therefore, in this present paper, to leave the too-much-belauded bee, with the flowers that cater for his tastes, entirely out of consideration, and look only

at some of the peculiar blossoms which appeal rather to the senses and sensibilities of other and more original insect guests.

The wasp, though undoubtedly an irascible and ill-balanced creature, and a *chauvinist* of the fiercest description, is yet a person of far more width of mind and far wider range of experience in his own way than the *borné* and conventional bee. His taste, in fact (like the taste of that hypothetical person, the general reader), is quite omnivorous: while he does not refuse meat, he has an excellent judgment in the sunny side of peaches, and he can make a meal at a pinch off the honey in more than one kind of wasp-specialized flower. But the peculiar likes and dislikes of wasps have produced a curious effect upon the shape and hue of the blossoms which owe their traits to these greedy and not very æsthetic insects. Your bee has a long proboscis and a keen sense of color; so the flowers that lay themselves out on his behalf store their honey at the end of a long tube, and rejoice in brilliant blue or crimson or purple petals. Your wasp, on the other hand, in his matter-of-fact Philistine fashion, cares for none of these things: he asks only plenty of honey, and no foolish obstructions in the way of getting it. Accordingly, wasp-flowers are remarkable for having a helmet-shaped tube, exactly fitted to a wasp's head, with abundant honey filling the bottom of the bell, while in color they are generally a peculiar livid reddish brown, more or less suggestive of a butcher's shop.

We have two or three good typical wasp-flowers, wild or cultivated, in England, of which the snowberry of our shrubberies is probably the best known to the outside public, other than wasps. But the dingy fig-worts that grow by the water-side are far more noteworthy, because they have such extremely odd-looking, one-sided blossoms, made to measure by nature for the wasp's head. The minuteness with which plants adapt themselves to the merest tricks of habit in the insects to whom they are habitually at home is very well illustrated in this queer plant. Bees and butterflies, and all other regular flower-haunters, have a trick of beginning at the bottom of a spike of flowers (as in foxglove or sage), and working gradually upward; so in these cases the pollen-bags ripen first, while the sensitive surface of the seed-vessel doesn't mature till a later period. Thus, the bee, lighting first on the older and lower flowers, in their second stage, fertilizes them with the pollen he has brought from the last plant; while on the upper part of the spike he gathers more pollen, which he carries away to the next plant, and so insures the great desideratum of nature, a healthy cross. But the wasp, with his usual perversity of disposition, reverses all this: *he* begins at the top of the spike, and works gradually downward. To meet this abnormal fancy of the vespine intellect, the fig-wort makes its sensitive surface mature first, while its pollen-bags only shed their mealy dust a little later. So the wasp, lighting first on the newly opened blossoms at the top, comes in

contact with the ripe summit of the seed-vessel, on which he rubs the pollen from the last spike he visited; and then, proceeding downward, he unconsciously collects a fresh lot to carry away to the next fig-wort. Of course, the wasp himself is not in the least interested in these domestic arrangements of the plant whose honey he seeks; all he wants is his dinner, but in getting it he is compelled, without at all suspecting it, to act as carrier for the fig-wort from one spike to another.

Wasps are remarkably sharp and wide-awake insects; and it would be very difficult indeed to take them in. Flowers that bid for their attentions must provide real honey, and plenty of it. It is quite otherwise, however, with flies. Those mixed feeders are the stupidest and most gullible of all insects; and many unprincipled blossoms have governed themselves accordingly, and deliberately laid themselves out to deceive the poor foolish creatures by false appearances. On most mountain bogs in Britain one can still find a few pretty white flowers of the rare and curious Grass of Parnassus. They have each five snowy petals, and at the base of every petal stands a little forked organ, with eight or nine thread-like points, terminated, apparently, by a small round drop of pellucid honey. Touch one of the drops with your finger, and, lo! you will find it is a solid ball or gland. The flower, in fact, is only playing at producing honey. Yet so easily are the flies for whom it caters taken in by a showy advertisement, that not only will they light on the blossoms and try most industriously for a long time together to extract a little honey from the dry bulbs, but even after they have been compelled to give up the attempt as vain they will light again upon a second flower, and go through the whole performance again, *da capo*. The Grass of Parnassus thus generally manages to get its flowers fertilized with no expenditure of honey at all on its own part. Still, it is not a wholly and hopelessly abandoned flower, like some others, for it does really secrete a little genuine honey quite away from the sham drops, though to an extent entirely incommensurate with the pretended display.

Most of the flowers specially affected by carrion-flies have a lurid red color, and a distinct smell of bad meat. Few of them, however, are quite so cruel in their habits as Rafflesia. For the most part, they attract the insects by their appearance and odor, but reward their services with a little honey and other allurements. This is the case with the curious English fly-orchid, whose dull purple lip is covered with tiny drops of nectar, licked off by the fertilizing flies. The very malodorous carrion-flowers (or *Stapelias*) are visited by blue-bottles and flesh-flies, while an allied form actually sets a trap for the fly's proboscis, which catches the insect by its hairs, and compels him to give a sharp pull in order to free himself: this pull dislodges the pollen, and so secures the desired cross-fertilization. The Alpine butterwort sets a somewhat similar gin so vigorously that when a weak fly is caught

in it he can not disengage himself, and there perishes wretchedly, like a hawk in a keeper's trap.

These cases lead on naturally to certain other very queer flowers which similarly take advantage of the stupidity of flies by actually imprisoning them (without writ of *habeas corpus*) in a strong inner chamber, until they have duly performed the penal servitude of fertilization enjoined upon them by the inexorable blossom. The South European birthwort, a very lurid-looking and fly-enticing flower, has a sort of cornucopia-shaped tube, lined with long hairs, which all point inward, and so allow small midges to creep down readily enough, after the fashion of an eel-buck or lobster-pot. *Sed revocare gradum, superasque evadere ad auras*—to get out again is the great difficulty. Try as they will, the little prisoners can't crawl back upward against the downward-pointing hairs. Accordingly, they are forced, by circumstances over which they have no control, to walk aimlessly up and down their prison-yard, fertilizing the little knobby surface of the seed-vessel with pollen brought from another flower. But, as soon as the seeds are all impregnated, the stamens begin to shed their pollen, and dust over the gnats with the copious powder. Then the hairs all wither up, and the gnats, released from their lobster-pot prison, fly away once more on the same fool's errand. Before doing so, however, they make a good meal off the pollen that covers the floor, though they still carry away a great many grains on their own wings and bodies. One might imagine that, after a single experience of the sort, the midges would have sense enough to avoid birthwort in future; but your midge has really no more intelligence than your human drunkard, or gambler, or opium-eater. He flies straight off to the very next birthwort he sees, conveys to it the pollen from the last trap he visited, and gets confined once more in the inner chamber, till the plant is prepared to let him out again on ticket-of leave of short duration. Thus, like an habitual criminal, he spends almost all his time in getting from one jail into another. His confinement, however, is not solitary, but is mitigated by congenial intercourse with the ladies and gentlemen of his own kind.

A very similar but much larger fly-cage is set by our own common wild arum, or cuckoo-pint. This familiar big spring flower exhales a disagreeable, fleshy odor, which, by its meat-like flavor, attracts a tiny midge with beautiful iridescent wings and a very poetical name, *Psychoda*. As in most other cases where flies are specially invited, the color of the cuckoo-pint is usually a dull and somewhat livid purple. A palisade of hairs closes the neck of the funnel-shaped blossom, and repeats the lobster-pot tactics of the entirely unconnected South European birthwort. The little flies, entering by this narrow and stockaded door, fertilize the future red berries with pollen brought from their last prison, and are then rewarded for their pains by a tiny drop of honey, which slowly oozes from the middle of each embryo

fruitlet as soon as it is duly impregnated. Afterward, the pollen is shed upon their backs by the bursting of the pollen-bags; the hairs wither up, and open the previously barricaded exit, and the midges issue forth in search of a new prison and a second drop of honey. This is all strange enough; but stranger still, I strongly suspect the arum of deliberately hocusing its nectar. I have often seen dozens of these tiny flies rolling together in an advanced stage of apparent intoxication upon the pollen-covered floor of an arum-chamber; and the evidences of drunkenness are so clear and numerous that I incline to believe the plant actually makes them drunk in order to insure their staggering about in the pollen and carrying a good supply of it to the next blossom visited. It is a curious fact that these two totally unrelated plants (birthwort and arum) should have hit upon the very same device to attract insects of the same class (though not the same species). The trap must have been independently developed in the two cases, and could only have succeeded with such very stupid, unintelligent creatures as the flies and midges.

From plants that imprison insects to plants that devour insects alive is a natural transition. The giant who keeps a dungeon is first-cousin to the ogre who swallows down his captives entire. And yet the subject is really too serious a one for jesting; there is something too awful and appalling in this contest of the unconscious and insentient with the living and feeling, of a lower vegetative form of life with a higher animated form, that it always make me shudder slightly to think of it. Do you remember Victor Hugo's terrible description (I think it is in "Quatre-Vingt-Treize") of the duel between the great gun that has got loose from its chains on a ship in a storm, and the men who try to recapture it? Do you remember how the gun lunges, and tilts, and evades, and charges, exactly as if it were a living, sentient creature; and yet all the while the full horror of the thing depends upon the very fact that it is nothing more than a piece of lifeless, senseless metal, driven about on its wheels irresponsibly by the fury of the storm? Well, that description is awful and horrible enough; but it yet lacks one element of awesomeness which is present in the insect-eating plants, and that is the clear evidence of deliberate design and adaptation. When a crumbling cliff falls and crushes to death the creatures on the beach beneath it, we see in their fate only the accidental working of the fixed and unintentional laws of nature; but when a plant is so constructed, with minute cunning and deceptive imitativeness, that it continually and of malice prepense lures on the living insect, generation after generation, to a lingering death in its unconscious arms, there seems to be a sort of fiendish impersonal cruelty about its action which sadly militates against all our pretty platitudes about the beauty and perfection of living beings. It is quite a relief that we are able nowadays to shelve off the responsibility upon a dead materialistic law like natural selection or survival of the fittest. Hartmann's "Uncon-

scious" stands modern naturalists in good stead *vice* the personal interference of the mediæval or Miltonic devil, absent on leave.

On most English peaty patches there grows a little reddish-leaved, odd-looking plant, known as sun-dew. It is but an inconspicuous, small weed, and yet literary and scientific honors have been heaped upon its head to an extent almost unknown in the case of any other member of the British floral commonwealth. Mr. Swinburne has addressed an ode to it, and Mr. Darwin has written a learned book about it. Its portrait has been sketched by innumerable artists, and its biography narrated by innumerable authors. And all this attention has been showered upon it, not because it is beautiful, or good, or modest, or retiring, but simply and solely because it is atrociously and deliberately wicked. Like the late Mr. Peace and the heroes of the Newgate Calendar, it owes its vogue entirely to its murderous propensities. Sun-dew, in fact, is the best known and most easily accessible of the carnivorous and insectivorous plants.

The leaf of the sun-dew is round and flat, and is covered by a number of small red glands, which act as the attractive advertisement to the misguided midges. Their knobby ends are covered with a glutinous secretion, which glistens like honey in the sunlight, and so gains for the plant its common English name. But the moment a hapless fly, attracted by hopes of meat or nectar, settles quietly in its midst, on hospitable thoughts intent, the viscid liquid holds him tight immediately, and clogs his legs and wings, so that he is snared exactly as a peregrine is snared with bird-lime. Then the leaf with all its "red-lipped mouths" (I will own up that the expression is Mr. Swinburne's, *ubi supra*) closes over him slowly but surely, and crushes him by folding its edges inward gradually toward the center. The fly often lingers long with ineffectual struggles, while the cruel crawling leaf pours forth a digestive fluid—a vegetable gastric juice, as it were—and dissolves him alive piecemeal in its hundred clutching suckers. I have seen this mute tragedy enacted a thousand times over on the bogs and moorlands; and, though I often try to release the fresh flies from their ghastly living but inanimate prison, it is impossible to go round all the plants on a whole common, like a philodipterous Howard, ameliorating the condition of all the victims of misplaced confidence in the good intentions of the treacherous sun-dew.

Our little English insectivorous plants, however (we have at least five or six such species in our own islands), are mere clumsy bunglers compared to the great and highly developed insect-eaters of the tropics, which stand to them in somewhat the same relation as the Bengal tiger stands to the British wild-cat or the skulking weasel. The Indian pitcher-plants or Nepenthes bear big pitchers of very classical shapes (it is well known that Greek art has largely affected India), closed in the early state with a lid, which lifts itself and opens the pitcher as soon as the plant has fully completed its insecticidal arrange-

ments. In some kinds the pitcher ludicrously resembles a hot-water jug of modern British manufacture. The details of the trap vary somewhat in the different species, but as a whole the *modus operandi* of the plant is somewhat after this atrocious fashion: The pitcher contains a quantity of liquid, that of the sort appropriately known as the Rajah holding as much as a quart; and the insect, attracted in most cases by some bright color, crawls down the sticky side, quaffs the unkind Nepenthe, and forgets his troubles forthwith in the vat of oblivion prepared for him beneath by the delusive vases. A slimy Lethe flows over his dissolving corse, and the relentless pitcher-plant sucks his juices to supply his own fibers with the necessary nitrogenous materials.

The Californian pitcher-plant, or Darlingtonia, is a member of a totally distinct family, which has independently hit upon the same device in the Western world as the Indian Nepenthes in the Eastern hemisphere. The pitcher in this case, though differently produced, is hooded and lidded like its Oriental analogue; but the inside of the hood is furnished with short hairs, all pointing inward, and legibly inscribed (to the botanical eye) with the appropriate motto, "*Vestigia nulla retrorsum.*" The whole arrangement is colored dingy orange, so as to attract the attention of flies, and it contains a viscid digestive fluid in which the flies are first drowned and then slowly melted and assimilated. The pitchers are often found half full of dead and decaying assorted insects. This circumstance, of course, has not escaped the sharp eyes of the practically minded Californians, who accordingly keep the pitchers growing in their houses, to act as fly-catchers. Such an ingenious utilization of nature, in unconscious competition with the *papier moule*, would surely have occurred only to the two great Pacific civilizations of the Californian and the heathen Chinee.

There are a great many more of these highly developed insect-eaters, such as the Guiana heliamphora (more classical shapes), the Australian cephalotus, and the American side-saddle flowers, and they all without exception grow in very wet and boggy places, like our own sun-dews, butterworts, and bladderworts. The reason why so many marsh-plants have taken to these strange insect-eating habits is simply that their roots are often very badly supplied with manure or with ammonia in any form; and, as no plant can get on without these necessaries of life (in the strictest sense), only those marshy weeds have any chance of surviving which can make up in one way or another for the native deficiencies of their situation. The sun-dews show us, as it were, the first stage in the acquisition of these murderous habits; the pitcher-plants are the abandoned ruffians which have survived among all their competitors in virtue of their exceptional ruthlessness and deceptive coloration. I ought to add that in all cases the pitchers are not flowers, but highly modified and altered leaves, though in many

instances they are quite as beautifully colored as the largest and handsomest exotic orchids.

The principle of Venus's fly-trap is somewhat different, though its practice is equally nefarious. This curious marsh-plant, instead of setting hocused bowls of liquid for its victims, like a Florentine of the fourteenth century, lays a regular gin or snare for them, on the same plan as a common snapping rat-trap. The end of the leaf is divided into two folding halves by the midrib, and on each half are three or five highly sensitive hairs. The moment one of these hairs is touched by a fly, the two halves come together, inclosing the luckless insect between them. As if on purpose to complete the resemblance to a rat-trap, too, the edges of the leaf are formed of prickly, jagged teeth, which fit in between one another when the gin shuts, and so effectually cut off the insect's retreat. The plant then sucks up the juices of the fly, and, as soon as it has fully digested them, the leaf opens automatically once more, and resets the trap for another victim. It is an interesting fact that this remarkable insectivore appears to be still a new and struggling species, or else an old type on the very point of extinction, for it is only found in a few bogs over a very small area in the neighborhood of Wilmington, Southern California.

Strongly contrasting with the æstheticism of the artistically minded bees, who go in chiefly for peacock blues and Tyrian purples, as well as with the frank Philistinism of the carrion-flies, who like good, solid, meaty-looking red and brown flowers, is the ingenious secretiveness of the ichneumon-flies, who chiefly patronize invisible green blossoms, indistinguishable to a casual observer among the thick foliage in whose midst they grow. Most insects are very casual observers: they require a good sensible flaring patch of yellow or scarlet (like the posters of a country circus) to attract their giddy attention. But the ichneumons are sharp-eyed and highly discerning creatures, which have developed a whole set of pale-green flowers, so inconspicuous as to escape the notice of color-loving bees and butterflies, yet with a good supply of easily accessible honey to reward their cunning visitors. This honey the monopolist ichneumons of course keep strictly for their own use. That large and very odd-looking English orchid, the tway-blade, extremely common in woods and shady places, though seldom observed by the general public on account of its uniform greenness, is an excellent example of these ichneumon-made blossoms. The whole spike stands a foot and a half high, with numerous separate green flowers, each about half an inch long, yet it is very little noticed save by regular plant-hunters, because its color makes it all but indistinguishable among the tall grasses and sedges with whose blades it is closely intermingled. Yet, if it were only pink or purple, like most of the other English orchids, it would certainly rank as one of the largest and handsomest among our native wild-flowers.

In a few cases, the relation between the plant and the insect that

habitually fertilizes it is even closer and more lasting than in any of the instances we have yet considered. Everybody knows those large and handsome tropical lilies, the yuccas, with their tall, clustered heads of big white blossoms. Well, Professor Riley, the great American entomologist, has shown that the yuccas are entirely run (to use a favorite expression of his countrymen) by a comparatively small and inconspicuous moth, solely for its own benefit: and so completely is this the case, that the yucca can't manage to exist at all without its little winged intermediary. Professor Riley has, therefore, playfully named the little insect *Pronuba yuccasella;* freely translated, the yucca's bridesmaid. The moth bores the young capsule of the flower in several places, lays an egg in each hole, and then carefully collects pollen, with which it fertilizes the blossom, of set purpose, thus deliberately producing a store of food for its own future larvæ. The eggs hatch inside the capsule, and the young grubs eat part of the seeds, at the same time prudently leaving enough for the continuation of the yucca family in the future. As soon as the grubs are full-grown, they bore a hole again through the capsule, lower themselves by a thread to the ground, and there spin a cocoon which lies buried in the earth all through the autumn and winter. But in the succeeding summer, just fourteen days before the yuccas begin to flower, the grubs in their cocoons pass into the chrysalis stage; and, by the time the yuccas are in full blossom, they issue forth as perfect moths, and once more commence the fertilization of their chosen food-plant, and the laying of their own eggs. So singular an instance of mutual accommodation between flower and insect is rare indeed in this usually greedy and self-regarding world.

The extremely odd, inside-out, topsy-turvy flowers of the fig owe their fertilization, however, to a still more extraordinary and complicated cross-relationship. Hardly anybody (except a botanist) has ever seen a fig-flower, because it grows inside the stalk, instead of outside, and so can only be observed by cutting it open lengthwise. The fig, in its early youth, in fact, consists of a hollow branch on whose inner surface a number of very small flowers cluster together; and, when they are ripe for fertilization, the eye or hole at the top opens to admit the insect visitor. This visitor is the fig-wasp, who comes, not from other cultivated fig-trees, but from a wild tree called the caprifico. On this tree the mother wasps first lay their eggs in the inedible figs, which thereupon swell out into galls, and become the nurses of the young wasp-grubs. When the wasps are mature, they eat their way out of the wild fig where they were born, and set forth to lay their own eggs in turn, either on a brother caprifico or on its sister, a true fig-tree. Those wasps which enter the wild figs of a caprifico succeed in carrying out their maternal purpose, and lay their eggs on the right spot for more grubs to be duly developed. But those which happen to go into a true fig merely fertilize the flowers without laying

their eggs, because the figs are here so constituted that there is no proper place for them to lay on. In other words, the true fig is a cultivated wasp-proof caprifico. But, as the figs won't properly swell without fertilization, it becomes important to conciliate the attentions of the wasps ; and for this reason the Italian peasants hang small branches of the caprifico on the boughs of the cultivated fig-trees, at the moment when the eye of the fig opens, and so shows that they are ready to be fertilized. The wasps, as they emerge from their own homes, enter the figs at once, and there set the little hard seeds, on whose impregnation the pulpy part of the fig begins to swell. The fruit of the caprifico itself never comes to anything, as it hardens and withers on the tree ; but, since the true figs are dependent upon it for pollen, it follows that, if the caprificos were ever to become extinct, the supply of best Eleme in layers would forthwith cease entirely.—*Cornhill Magazine.*

ALCOHOLIC TRANCE.

By T. D. CROTHERS, M. D.

I PROPOSE to describe in a general way a peculiar mental state following the toxic use of alcohol, which has only recently attracted attention, and which promises to be a very imporant factor in the medical jurisprudence of the future. Morbid states of the nervous system, in which the mind seems to act automatically, and without consciousness of the surroundings, and with no registration by the memory of these acts, are not new to students of mental and nervous diseases ; but the fact that they are more or less common in inebriety from alcohol, and may follow any excess, is a recent discovery. In 1879 I published a short paper " On Trance and Loss of Consciousness following Inebriety," which, as far as I can ascertain, was the earliest study of these cases ever made. The following are among the first cases which attracted my attention to this subject. In 1877 a patient was admitted to the asylum at Binghamton, with this incident in his history : A year before, while apparently sober, he purchased a trotting-horse, paying a fabulous price. Two days after, he denied all knowledge of the transaction, and became involved in a lawsuit. On the trial it appeared that the purchase of the horse had been discussed for many hours, and that the buyer had exhibited great sagacity and judgment to avoid deception ; also that, although drinking large quantities of spirits, he gave no evidence of other than good judgment, and perfect knowledge of his acts and their consequences. In the defense it was shown that the purchase of the horse was a most unusual act ; that he never showed any interest in fast horses, or racing, nor had he been on the race-course, and was in fact afraid of driving fast horses ; and,

lastly, he had many horses in his stables, and needed the money paid for this horse, for a distinct purpose, which had been determined on before. From his own testimony he had many blanks of memory while drinking, and at this time had lost all recollection of passing events from the hour of dinner, during which he drank freely, until next morning, when he drank again and fell into another blank which lasted thirty-six hours. Other testimony indicated a gradual increasing dullness and abstractedness of manner during this time ; also apparent disinclination to fix his attention on any one thing long. The suit went against him, and he soon after was brought to the asylum. In another case the president of a bank, a man of wealth and irreproachable character, forged a large check, put the money in his pocket, and the day after was amazed to find the money and to account for it. In an investigation it was proved that he suffered from these blanks of memory after drinking wine freely ; that he had before done many unaccountable acts, apparently fully conscious at the time, and yet afterward disclaimed all memory of them, a fact which was supported by their motiveless character. This mental condition may be described as a loss of memory and consciousness of present and passing events, that is concealed and not apparent from a general study of the conduct ; or, in other words, a state of the brain similar to somnambulism in respect to the unconscious character of the acts, and all recollection of them. For the time being the sufferer is a literal automaton, giving little or no evidence of hisactual condition, and acting from impulses unknown, and motives that leave no trace.

The late Dr. Beard believed this state to be one of general lowered brain-function, in which the cerebral activity is concentrated in some limited region of the brain, and is largely suspended in the rest. He also urged that the plane of consciousness was below the point of remembering ; hence these cases were conscious at the time, but the memory failed to record the impression. In confirmation of this, the late Dr. Forbes Winslow recorded a case of a somnambulist who, while walking about, set his night-dress on fire, and with excellent judgment and coolness threw himself on the bed and extinguished the flames, then resumed his walk, and awoke next morning with no memory of it, and was greatly alarmed at the charred appearance of his dress. Whatever the pathology may be, it is clear that this is a state of irresponsibility, and for the time being a form of dementia and insanity, about which there can be no question. Careful study of these cases for many years has indicated the startling fact that they are very common in inebriety ; also that in every case where alcohol is used to excess there are histories of loss of memory and consciousness of acts committed while using spirits. These conditions are almost infinite in variety and complexity, and are considered mere freaks of memory by many persons. Probably in a majority of cases in the early stages these blanks of consciousness and memory are partial, and appear in the

delirium or stupor which follows excess of spirits, or in mental states approaching it, and clear up after recovery, or remain like a cloud for weeks, then from some little circumstances break away and every act is recalled. In other cases only a dim, vague impression remains of what has transpired in the past, which may or may not become clear with time ; or the blank may be total for the time being, and then break away. In many of these cases there is apparent realization of all his acts and words, in others a self-evident unconsciousness of them. This is only the beginning of another and more pronounced stage, in which the blank of memory and consciousness is total, and during this period the acts and appearance of the person differ but little from those of usual health. In many cases the brain function or action, as seen in his acts, is fully up to the best state of health, even showing more than usual strength in some directions. In a paper read before the Medico-Legal Society of New York, in 1881, I discussed this condition as a trance state following inebriety ; since that time a number of different names have been suggested by authors, such as inebriate automatism, inebriate insanity, inebriate unconsciousness—all describing the same condition. The following may be mentioned as facts that are generally accepted as landmarks from which further study may be dated :

1. This trance state is a common condition in inebriety, where, from some peculiar neurotic state, either induced by alcohol, or existing before alcohol was used, or exploded by this drug, a profound suspension of memory and consciousness and literal paralysis of certain brain-functions follow.

2. This trance state may last from a few moments to several days, during which the person may appear and act rationally, and yet be actually a mere automaton, without consciousness or memory of his actual condition.

3. This trance state may be noted by criminal impulses and by unusual thoughts and acts foreign to all the man's past history. In all these cases there are no apparent disturbances of the nervous system, no convulsions, no premonitions to mark this state ; at some unknown point, all unconscious, the eclipse begins. A comparison of the history of a number of cases will show three mental conditions quite prominent : 1. In which the mind in this state acts along certain accustomed lines of thought and action ; 2. In which the mind displays unusual ranges of thought and action, which in some cases can be traced to certain mental states growing out of the surroundings ; and, 3. Where criminal impulses are prominent, that have no apparent connection with the present or past. These conditions may be illustrated in the following cases : A railroad conductor, who drank to excess every night after the day's work was over, would frequently get up in the morning, go out on his train, perform all his duties correctly, and recover consciousness of himself suddenly on the

road, and all the past be a blank to him from some point the night before. These blanks occasionally lasted twenty-four hours, and he could never recall anything which happened, and only knew by the money and tickets that he had made a trip on his train. After a time he would put down in a note-book events of importance in this state, which he never did otherwise. The train-hands knew that he was, as they termed it, "memory-drunk," when he used his note-book freely, and seemed dull and abstracted. A pilot on a Sound steamer, after seasons of hard work, and exhaustion from loss of sleep, would use brandy to keep up, and have blanks of hours from which he would recover, having no recollection of what had happened. He would act as usual, only be less talkative, and dull in his manner. A skilled mechanic, who used spirits to excess, suffered from blanks of many hours' duration, during which he attended a dangerous machine, performing all the duties, requiring both skill and judgment. A clergyman, who drinks wine, has frequently conducted service, and preached a sermon without any memory of the fact, having a blank of all surroundings for hours. A grocer, after a period of great excess in the use of spirits, will conduct his business for hours without any consciousness of events, and only know by the books and the statements of others what has taken place. These are only a few of the histories of a large number of cases which I have gathered to illustrate the fact that in this trance state the mind may work along accustomed lines of thought and action. In this condition, the evidence of a mental blank is more or less obscure. In the next division, the mind displays unusual ranges of thought and action, some of which can be traced to the surroundings. A physician, who drank constantly, and was a bitter skeptic, went into a revival meeting and professed change of heart, and took part in the exercises, and the next morning had no recollection of it. Later, while drinking, he heard the singing of the revival meeting, and, dropping all business, entered and took a very active part, and seemed fully conscious of all the surroundings, yet, after a night's sleep, had no recollection whatever of anything which had occurred. In this case the trance state was manifest in unusual deeds and acts, suggested from the surroundings. A similar case was that of an editor, who, after drinking to excess, could always be found in temperance-meetings, making eloquent appeals, and yet he gave no evidence of being under the influence of spirits, nor could he remember anything of what had occurred. Another case is that of a man of fortune, who drank wine freely, awoke and found that he had married his servant, and made an unusual disposition of his property, which was all a blank to him. To his friends and others he seemed fully conscious of the nature and consequences of these events at the time. I think it will be found that inebriates brought suddenly into conditions of excitement are moved by circumstances and surroundings to which they are often really oblivious. If the trance state is pres-

ent, the influence of the surroundings can not be estimated. The last division, that of *criminal impulse growing out of this trance state,* illustrates the subject of our paper more closely. The following cases bring out the facts better than any description: An inebriate was repeatedly arrested for horse-stealing, and often punished. The crime was committed under similar circumstances, and no attempt was made to conceal the property; on two occasions he assisted the owner to hunt up the horses. When it was apparent that he was guilty, great was his astonishment, and he denied all recollection of any circumstances or events. This was confirmed by all the circumstances of his life, by his inebriety and blanks of memory, and absence of motive and object in the crime. He was fond of horses, and seemed at this time to be governed by an impulse to drive and ride behind a good horse. A farmer of quiet, good disposition suffered from blanks of memory after drinking to excess. One day, in what seemed full consciousness of the surroundings, he attacked a stranger and injured him so that he died. He had no recollection of the time, purpose, or any circumstances of the tragedy. A periodical drinker, of wealth, fired his buildings, and awaking when they had burned down, offered a large reward for the incendiary. To his great astonishment, the fire was readily traced to him; the circumstances and motive were all a perfect blank. A man of much talent and eminence, who drinks occasionally to excess, has on many occasions offered violence to his wife, whom he loves very dearly. On these occasions he is apparently sober, gives reasons for his conduct, and afterward has not the slightest recollection of it. In a murder-trial recently, it appeared that a drinking man drank early in the morning, then killed his wife, and went about his work in the vicinity, as if nothing had happened, all unconscious until arrested. He was sentenced for life, but has a firm conviction that he did not commit the crime, because he can not conceive of a motive, and has no recollection of it. A clergyman committed a rape under the most extraordinary circumstances, and denied all recollection of it; his drinking habits and all the incidents of the case sustained his statement. A lawyer of reputation planned the abduction of a lady he was going to marry. A man of a large family and happy domestic relations married a notorious woman. A physician stole a large sum of money from a patient. A college graduate enlisted in the army. In each of these cases there was a history of drinking to excess, and each had no memory of the event, and all the circumstances were so unusual and at variance with previous conduct that undoubtedly a trance state was present. These cases might be multiplied almost indefinitely from the records of criminal courts everywhere. Every day the papers record cases of crime, without motive or purpose, by inebriates who, in defense, claim to have no recollection of it; but, as they were not wildly delirious or stupid at the time of committing the act, they are punished as fully responsible. When the crime is of magnitude, and

the defense is insanity, the explanation and theory are so far from the accepted views of experts as to confuse courts and juries, and be criticised and ridiculed by others. This defense occurs most frequently in two forms of cases: One, of a chronic inebriate, who is all the time more or less under the influence of spirits, and who lives in a low moral atmosphere, in bad physical surroundings. Suddenly he commits a crime, which is without motive, and seems a mere accident and result of unforeseen conditions. The second case is of a man who may be a periodical inebriate, and of good character and reputation in everything except excess of use of spirits; whose surroundings and general standing are good, and who commits a homicide or some strange crime under circumstances that are inadequate to explain or account for it. In both of these cases there is no recollection of any of the circumstances, and the defense is based on some specious reasoning and theories. There are evidently disorganized brain-power, mental and physical incoordination, with defect and unsoundness of the reasoning powers, which can not be made clear to the court and jury. The prevalence of the theological theory, that all these strange, unaccountable acts of inebriates, who are not stupid at the time, or wildly delirious, come from vice and sin, is fatal to all scientific study and progress. This condition of trance, noted by absence of memory and consciousness, has been discussed by Dr. Carpenter, of England, under the title of "Automatic Cerebration," from which I quote the following sentence: "I have noticed some cases of drunkenness, in which a suspension of memory and consciousness was noted, coming on unexpectedly, and then the patient was a victim to morbid impulses which he never realized or had any recollection of after." Dr. Hughlings Jackson writes at some length on mental automatism, following transient epileptic paroxysms, in which this same condition is described at length as a form of sudden paralysis of the cerebral functions, or conditions of hyperæmia and suspension of some controlling centers. The late Dr. Forbes Winslow describes a similar condition of trance and automatism where the person seemingly acted as fully recognizing right and wrong, although consciousness was obliterated. Dr. Hammond mentioned the case of a man who, after an attack of epilepsy, went about for eight days in a trance state, doing business, and having no memory of it. Dr. Hughes has also mentioned similar cases. Abroad many eminent specialists, including such names as Drs. Bucknill, Clouston, Mercer, and Motet, of Paris, and others, have described this state associated with epilepsy, and following mental shocks in persons who are drunkards. These references are presented to show that the trance state has been observed by eminent men, although not yet studied from the side of crime and responsibility. A large number of cases are constantly before the courts on trial for crime committed after and during excess in the use of alcohol—crime that is purposeless, without motive or object, and differing in the manner of execution, and effort to conceal

afterward, from other crime of similar nature—in some cases noted for apparent coolness, without excitement, and cold-heartedness or indifference to the nature of the act. In the defense, all recollection or consciousness of the event is denied, and many circumstances, seen both before and after the crime was committed, bear out this statement. These cases receive no study, and are punished, the result of which precipitates the victim into worse and more degenerate stages. Undoubtedly these cases are suffering from alcoholic trance, and have crossed the border-line of sanity and responsibility, and are as truly insane as the wildest maniac. In this trance state the person is a mere automaton in motion, either moving along certain fixed lines of conduct, or acting in obedience to unknown forces which may change or vary any moment. Some governing center has suspended, and all rememberable consciousness of time and the relation of events has stopped. Changing thoughts and impulses, the suggestion of a disturbed organ, or the impression of a thought or desire felt in the past, may suddenly concentrate into action irrespective of consequences. Both subjective and objective states, influenced by conditions of health and brain-power, may develop into acts that will be unknown and unrecorded by the higher brain-centers. Clinical facts within the observation of any one will indicate, without any kind of doubt, that in all cases of inebriety there are a defective brain-power and ability to recognize the natural relations of life in all particulars. The sufferer is more or less incapable of healthy normal thought and action; he has opened the door for many complex nervous disorders, and the natural process of tearing down the structure is greatly accelerated. If the trance state is found to be present, he has passed into the realm of practical irresponsibility and unconsciousness of the nature and character of his actions. I believe the following summary will be found to outline the future recognition and treatment of these cases:

1. Inebriety in all cases must be regarded as a disease, and the patient forced to use the means for recovery. Like the victim of infectious disease, his personal responsibility is increased, and the community with him are bound to insist on the treatment as a necessity.

2. Inebriety must be recognized as a condition of legal irresponsibility to a certain extent, depending on the circumstances of each individual case.

3. All unusual acts or crimes committed by inebriates, either in a state of partial stupor or alleged amnesia (or loss of memory), which come under legal recognition, should receive thorough study by competent physicians, before the legal responsibility can be determined.

4. When the trance state is established beyond doubt, the person is both physiologically and legally irresponsible for his acts during this period. But each case should always be determined from the facts of its individual history.

In the light of science the present legal treatment of inebriety is

but little else than barbarism. The object of the law, in punishment, benefits no one, and makes the patient more incurable—destroying all possibility of recovery and return to health again. Inebriety in any form may be no excuse for crime in a legal sense, but it is still less an excuse for punishment, which destroys the victim, or makes him more helpless and hopeless. A vast army of inebriates, hovering along these border-lands of disease and crime, who are unknown and unrecognized, except "as vicious and desperately wicked," are a perpetual menace to all progress and civilization, unless they can be reached and checked by rational, effective methods. A revolution of sentiment and practice is demanded, in which the inebriate and the conditions which developed his malady shall be understood; then the means for prevention, restoration, and recovery can be applied along the line of nature's laws.

THE PROBLEM OF UNIVERSAL SUFFRAGE.

By ALFRED FOUILLÉE.

THERE are three principal theories of suffrage. It may be regarded, first, as the final shape assumed by the struggle for existence among mankind. Since it is necessary, sooner or later, to come to a treaty of peace, let us make it before the battle, instead of afterward; let us put ballots in the place of gun-shots. We can thus gain an economy of men and strength, and a reserve of living power. Universal suffrage may be defined, from this point of view, as a device of modern society to make a canvass of its forces, and learn what proportion of them is arrayed on the one side or on the other.

The second theory is based on considerations of utility and common welfare. Modern nations, in their advancing freedom, are happy only as they do definitively what they wish, as they recognize in their present condition the result of their present will, while they reserve the power of modifying their situation on changing their wish. Though the opinion of all may not be the best possible, it is at least the most fit to satisfy everybody, and experience will teach wherein it may need amending. But what if it is too late to amend? Some experiments may lead to the loss of a province, or to the ruin of the nation. Mr. Spencer, indeed, tells us that as the vote of each individual is the expression of the wants that he feels, so the votes of the nation are the product of a generally felt want. But we reply that individuals can not feel or account for general wants, especially when they concern international affairs. Even in the internal affairs of a nation, a general want is not the simple sum of particular wants. There are superior interests, not intellectual, æsthetic, and moral only, but economical and political ones also, of which individuals as a mass can have neither

knowledge nor the mere feeling. On this point Mr. Spencer remarks that, although the vote of the people is not the expression of absolute utility and truth, it is the expression of the people's understanding of them, and of what they are ready to maintain. True ; but is the present moment all? Must we not think of to-morrow? The fault of the masses is want of foresight. They are instinctive, not reflective. To calculate the remote effects of a measure, to rise to the point of view of future generations, to be moderate now, to give up immediate pleasures for future good, perhaps for the sake of an idea that will never be realized, passes the scope of average minds. The fate of democracy is, then, subordinated to the existence of a real public and impersonal spirit in the majority of the individuals: if this spirit does not exist, universal suffrage is only a strife of individual interests—it dissolves the masses into their atomic elements, then arbitrarily gathers up the atoms, and scatters them to the winds. It may be said, and with truth, that the best means of developing a genuine public spirit in a nation is to call the whole people to political life, and that the participation of all in power is an exercise useful to all, and one that develops knowledge of the national affairs in all. But an important distinction must be made in the matter. It is the conquest of power, not its completed acquisition, that gives the most lively stimulus to progress in political intelligence. While the people are contending for their rights against oppression, their intelligence is growing ; when the masses have become preponderant, the current sets in in the contrary direction. Those who have the supreme power, whether it be one, a few, or many, have no longer need of the arms of reason ; they can make their mere will prevail. Men who can not be resisted are generally too well satisfied with their own opinions to be disposed to change them, or to be told without impatience that they are in the wrong. John Stuart Mill was right in conceiving that the best interest of democracy consisted in giving the different classes force enough to make reason prevail, but not enough to prevail against reason. The existing organization of suffrage is far from securing this guarantee.

The third theory of universal suffrage, higher and more correct than the theories of force and interest, is based on right. Public freedom is above public force and public interest, and is founded on individual freedom. The individual has no right to alienate, for the benefit of another, his own liberty and that of his descendants. The object of universal suffrage is to reserve the will of generations to come, and for that reason it involves the suppression of hereditary privileges, of aristocracies and monarchies, and of everything that shackles present and future freedom.

This principle is morally incontestable ; but the consequences derivable from it do not seem to be generally comprehended. From the point of right, suffrage seems to us to imply—1. A power over one's

self. 2. A power over others. 3. A public function exercised in the name of the whole nation. Most democratic theorists see only the first of these characteristics. The function of preserving individual liberty within the state is, indeed, one of the ends of suffrage; but, in voting, I not only vote for myself, I also exercise a power over the domain of other persons as they do over mine, just as much as though the question were one of the conveyance of an estate, or the division of its proceeds. This power over another, multiplied by the number of the voters, or of the majority, may become something formidable. Hence arises a second opinion that regards suffrage as a part of the power allotted by a reciprocal contract to each associate in the great civil and political society. Although this conception has a relative degree of truth, it appears to us to rest on an incomplete idea of the state. The state is not an arbitrary association, but one in which the members are bound in an historical and organic solidarity. Suffrage further acquires a third character, and appears as a social function, or a function of the collective consciousness. By means of it, we may say, all the cells of the political body are invoked to take their part in the intellectual and voluntary life. But the idea of function involves the idea of capacity to perform the function.

To see in suffrage, as is nearly always done, only a single aspect—whether it be the individual, or the contractual, or the social side—is to lose sight of one of its three constituent relations; the relation of the individual to himself, that of the individual to other individuals as such, or that of the individual to the state as an organic whole. In these three points of view, the right supposes a capacity—1. To govern one's self; 2. To exercise by the ballot a power over another; and, 3. To exercise a social function in the name of the state. This, if we are not mistaken, is the real and complete conception that embodies in the germ the whole philosophy of universal suffrage.

The part of the state is not generally better comprehended than that of the individual. The omnipotence of the state, falsely asserted by the radical school, becomes in practice the omnipotence of majorities. Actual democracies are simply the government of all by the largest number, instead of the government of all by all. The confusion which democrats here make of the universal right of suffrage with the practical expedient of majorities involves grave consequences and deserves to be examined.

The ideal of a perfectly free society would be that every law in it be the work of the unanimous will. Unanimity, the only adequate form of general liberty, already exists upon a number of points. We all desire to live in society, and to enter into the social contract; and we all prefer to live in that particular society which constitutes our nationality. There are also some things within that nationality on which unanimity exists. We all want roads and railroads; and, excepting the thieves, we all want police and courts. But there is a

point where divergences arise, and conflicts of opinions, interests, and rights. What are the means, when we come to divide at this point, of still securing the greatest agreement of liberties, and, in consequence, the highest degree of justice?

The points on which opinions are divided may be not incompatible with each one following his own choice, or they may be irreconcilable. In the former case there need be no difficulty in arriving at practical solutions, the scope of which should be extended as much as possible. By an intelligent decentralization, society may be broken up into groups, smaller and smaller, one after the other, without ceasing to be united at the common points. But who is to control in these circumstances, when the different wills are absolutely incompatible? Partisans of aristocracy say, those who have reason and right on their side. But how are we to ascertain who they are? We have no criterion for recognizing the bad and incapable as we have for distinguishing the infirm, the lame, and the diseased. Education is not a sufficient criterion of political capacity, for it does not do away with prejudices or with selfishness. Restricted suffrage, according to the lessons of experience, has exhibited the same vices as the suffrages of the greater number—corruptibility, prejudice, vanity, ignorance, distrust of liberty, and dependence. The middle and upper classes have no right to consider themselves better than the populace. Like the populace, they have their egotistical—or, as Bentham styles them, their "sinister"—interests, in opposition to the general interest. Wicked and incapable persons are as often met with in oligarchies as in the mass of the nation. History shows that all aristocracies have perished by their vices and incapacities, and that those who are assumed to be the best are frequently the worst. In calling all the citizens to power, under suitable conditions of capacity, we are doubtless exposed to the danger of calling in some worthless men, but we are still more exposed to it if we confer a privilege upon particular classes. The only difference is that, if the evil element exists in a close aristocracy, it soon corrupts the whole body; while, if it is scattered in a mass always open and mobile, it suffers dilution, and finally elimination. We are obliged, therefore, in the question of suffrage, to consider solely the quality of man and citizen aside from mental and moral qualities. As we can not weigh heads, we must count them. It is logical, when there is conflict, for numbers to decide, not because they are numbers, but because they represent the preponderance of rights and wills: "We unanimously agree to be governed by the majority." Those who do not approve this decision must submit, or step down and out. That is the principle on which the recognized right of majorities rests. But, although a necessary convention rules here, there is nothing in it to justify the pride of triumphant majorities, and the pretense that they represent, by the mere fact of their numbers, the national sovereignty. Majorities should be taught to comprehend that they are only

a provisional and feeble substitute for the universal will. They should not be allowed to persuade themselves that they necessarily represent truth and justice. And they should always remember that they were a minority before they became a majority. It is a law of history that every true and progressive opinion was at first that of a single man, then that of a minority, before it became that of the largest number. There are, then, great chances that the opinion of the future may be residing in one of the minorities that have been overcome by the majority; but in which? It is impossible to know. The error that is passing away and the truth that is coming are both in a minority; and it is precisely because we have no sufficient criterion to distinguish the dawn from the twilight that we content ourselves with the average opinion as offering the least chances of error and the most perfectible elements.

When a decision is to be made, the views of the majority and the minority can not, as we have seen, be reconciled; but, while the matter is under deliberation, they can be compared by giving a representation of all the opinions and permitting their expression. The brain can not decide for two contrary things at once, but it can deliberate over the conflicting views. The case is the same with the kind of national brain called a parliament. Mirabeau has compared representative assemblies to geographical maps, which should reproduce all the elements of the country with their proportions, without permitting the more considerable elements to overshadow the less considerable ones. Now, how far ought the proportionality of representation in such bodies to go? Should it aim at a nearly mathematical exactness, as the partisans of Mr. Mill and Mr. Hare demand? It may help us, in answering this question, to examine the nature and function of the different parties, of which we propose to assure the exact representation. In the view of social science, two kinds of forces are indispensable to the body politic, as well as to every living organism—conservative and progressive forces. These forces are personified in the two great parties that prevail in all modern states—the conservative liberal and the progressive liberal parties. Instead of mutually hating each other, these parties ought to comprehend that they are necessary one to the other, and both to the whole. From a psychological point of view, the state, which is an exaggerated man, and condenses in itself all the living forces of the man, should include simultaneously parties distinguishable from one another by differences corresponding to the successive ages of the individual. M. Bluntschli has constructed a fine psychology of parties, which, however, goes a little too far. Childhood is represented by radicalism. All the thoughts of childhood are for the future. A new world is opened before it, which it believes it can organize according to its fancy. Every formula taught in school seems to childhood a universally applicable truth; the radical thinks the same, and ascribes a magical power to his laws and institutions.

The child loves to push things to extremes, and, armed with his petty logic, goes from destruction to destruction without concerning himself about obstacles. How many theorists have reconstructed the state in the same manner! Universal suffrage should never forget that radicals may be good opponents, but are detestable governors. Unfortunately, in the real world of the ballot, even the violence of the radicals has a chance of success with the masses, to whom often it is enough to promise everything, to get everything from them.

The liberal progressive spirit corresponds with the age of youth and early manhood, which is especially distinguished by the development of the productive forces. The young man endeavors to assert himself, to produce, to take his place in the world. Liberal natures offer the same character, and the organizing power which they show is the infallible sign of true liberalism. The liberal loves liberty above everything else; but he suspects liberties that are granted or gotten up for the occasion. He has faith only in liberty that is innate, or that has been conquered by labor and effort. Progress is his aim.

The conservative liberal is the man, some forty or fifty years old, who is less concerned about acquiring new possessions than about improving and expanding those that he has. The conservative is less enthusiastic than the progressist, not that he does not appreciate his ideas, but because he more clearly sees the difficulty of realizing them. As the progressist above all loves liberty, the conservative loves pre-eminently the law which gives force and stability to relations that are recognized as necessary. Further, he attaches himself particularly to historic right, of which he maintains even the traditional form. He wishes the movement toward the future to respect the rights of the past. Thus he is little aggressive, and his particular force is the defensive. His natural place is after a revolution, or a fundamental transformation, when the living question is to preserve the conquests that have been made, and secure them against new abuses. Great legislators are generally progressists; great jurists are for the most part conservatives. Reactionary absolutism corresponds with old age, when life is declining and approaching its end, and the passive elements become preponderant. Its ideal is passive obedience; but, if its tranquillity is disturbed, it becomes irritable and cruel.

While we may recognize the part of truth in such a psychology of the parties, we need not believe that each age is rigorously analogous to any of the characters mentioned; the affair is one simply of general tendencies and means, which do not exclude individual differences. The progress of the state will be regular and consistent with a just conservation of acquired results, if the national representation is composed of two great liberal parties, one progressive and the other conservative, with a few elements of radicalism counterbalanced by a spice of absolutism. The two extremes are gradually becoming more restricted, to the advantage of moderate and liberal tendencies, and

suffrage should be organized so as to prepare for this result. It should be the object of democracy to accord the right of deliberation to all the constitutional parties in proportion to their strength, and to lodge the right of making a decision in the progressive liberal, counterpoised by the conservative liberal element. It is, however, not easy to achieve a practical realization by mathematical processes of the ideal of proportional representation; and the separation of the power of deliberation and the power of decision is hardly practicable under existing constitutions, by which the same assembly deliberates and decides. Philosophers should, nevertheless, continue to point out the end to be sought.

Besides the opposition of the majority and the minority bringing about a conflict of the constitutional parties, universal suffrage embodies another antinomy no less disquieting—that of the number and the quality of the votes. The problem of reconciling numerical superiority with mental superiority is a squaring of the circle for democracy. As approximative solutions, it has been proposed to express intellectual superiority by a numerical valuation, and allow a plural vote to the educated man; and so to instruct and enlighten the whole mass that the number of the suffrages shall, on the whole, coincide with their quality. John Stuart Mill has insisted upon the former method, or "plural suffrage," but the system is not without its dangers. It opens the door to arbitrary selections. Particular classes, assuming too many votes for themselves, would finally become oligarchies, the more probably because the educated classes are also those in easier circumstances. The only case in which a plurality of suffrages would be, in our view, at all admissible, would be that in which the individual really represented several persons, as the father of a family, who might, in virtue of his wife and children, have two votes. The best means of resolving, in part if not entirely, the antinomy of right and capacity is, in our view, education; but its character should be rightly understood.

By the theory of universal suffrage, the mass of the citizens should desire the general good rather than their particular interests, and they should have a sufficient discernment of it to impress good direction on their policy. Education should, then, develop, as the two essential qualities of the citizen, moral disinterestedness and political sense. Our present system of education does not seem to respond, in any of its departments, to this double requirement. We owe much to the mathematical and physical sciences that are now held in so much honor, but we have no reason for believing that they are competent to make citizens morally disinterested or politically capable. Purely scientific instruction has proved no better for this than that which is purely grammatical. Criminal statistics has not shown that any great advantage accrues even to those who simply know how to read, write, and reckon; but it has revealed more criminality among working-men

than among peasants, even though the working-men may be the better instructed. Some statisticians have remarked that the moral influence of knowledge begins to be real at the moment when learning ceases to be a tool to become a work of art. To exert a moral influence is, in fact, to raise minds above egotist views and purely material interests, toward general ideas and impersonal sentiments. For that reason, instruction should be not only professional, and technical or scientific, but literary and æsthetic as well.

The citizen of a democracy must, further, have precise knowledge in public polity, and this should be made obligatory. It may be that a man has a right to be and continue incapable in matters that concern himself alone, but that can not be allowed in affairs that concern all. Society as a whole must demand some guarantees from the associated individuals—a certain maturity, not of age alone, but also of intelligence and education. John Stuart Mill says that the elector ought to be able to copy a few lines of English, and do a sum in the rule of three. We have not much faith in the virtue, in this matter, of the rule of three. Reading, writing, and arithmetic are double-edged blades; everything depends on what one reads and how he uses his arithmetic. Mr. Spencer remarks with much force that the multiplication-table will not help one to comprehend the falsity of the socialist dogmas. What good does the laborer's ability to read do him if he only reads what confirms him in his delusions? The higher grades of instruction are doubtless more efficacious than the primary; but they are far from being of themselves competent to develop political capacity. Mr. Spencer, having shown how poorly prepared is the English university graduate, with his knowledge of Homer and Sophocles, to perform his duties as a member of Parliament, adds that to prepare a person for political life he ought to be given education in politics, while the contrary is done. Yet, when we wish to teach our daughters to become good musicians, we do not furnish them with a painter's apparatus, but seat them in front of a piano. The classical studies, so much criticised, have at least an æsthetic and moral influence, if they do not develop the political sense; but the study of the sciences, as it is ordinarily pursued, has neither of these advantages. Our courses are overcharged with historical and scientific studies, the tendency of which is to overload the memory of the pupils, without developing their judgment or elevating their character, and the result has been deplorable. Courses charged with calculations, analyses, and classifications, can not even contribute to the moral and intellectual elevation of the mind. There should be taught, besides the elementary and practical principles, the most speculative principles, and the most general results of the sciences, or, in short, their philosophy. In this way only has science an educational virtue; in this way it lifts the mind instead of merely furnishing the memory, and is liberal instead of servile and military. As usually taught, it serves only to

prepare, for examination-day, answers the most of which will be forgotten a month afterward.

But we are asked, Is not science the investigation of truth, and does not this imply a love of truth, a disinterested love fruiting in abnegation and sacrifices? Oh, yes, a great scientific man has said that truth surrenders to the patience of students, to simplicity and devotion as well as to genius. But the search for truth is one thing, and truth already discovered and taught passively is another thing. In scientific instruction, as it is commonly given, only acquired results are presented to the pupils, without teaching at the cost of what efforts they have been gained—only truths that have been cooled off, lifeless truths and soulless formulas. For moral effect, we should give the history of science and of scientific men, intermixed with the exposition of the sciences; but we prefer to teach a hundred more theorems or formulas, which our pupils hasten to forget. Thus taught, separated from philosophy and history, science has neither moral virtue nor civil import. It degrades instead of elevating, makes machines and not men, still less citizens. A considerable part should, then, be given, in teaching of every grade, to letters, the arts, and the moral, social, and political sciences. On this point Mr. Spencer and M. Bluntschli agree in the assertion that there can be no liberty, no vote in democracies, without a good political education. The child can hardly grasp the idea of the state, and can only receive extremely vague and dull notions respecting the political constitution. He should be inspired with ideas of public morals, civic virtues, and patriotism, and rather by examples than by precepts. This political instruction should be continued in a higher and more practical but always unpartisan form for youth who are approaching the time when they will exercise the right of suffrage. It is as dangerous to thrust into political life young persons who are strangers to all political knowledge as it is to send soldiers into battle without having drilled them in military exercises. Defense against the assaults of internal barbarians is as essential in democracies as defense against foreign invasions. Examinations have been instituted in Belgium for candidates for admission to participation in the right of suffrage, and the example might be a good one to follow.*

* The new electoral law of Belgium establishes, as the basis of the electorate, a standard of mental and moral capacity. A jury subjects the candidates to an "electoral" examination upon simple questions of morals, Belgian history, constitutional institutions, reading, writing, arithmetic, and geography. Before coming to this point, experiments were made upon the results of primary instruction. Cadets, who had been five or six years at school, were put to the test of an extremely simple examination. They were asked, for example, to tell the four large cities of the country, and the rivers on which they are situated. Thirty-five per cent made no answer, and forty-nine per cent only made a partial answer. To the question, By whom are the laws made? fifty per cent had nothing to say; twenty-eight per cent replied, They are made by the king, or by the king and queen, or by the ministers, or by the Government, or by the Senate; and fifteen per cent answered with knowledge. When asked to name an illustrious

Not only should primary political instruction be extended and fortified, but a secondary and superior political instruction should be created, for they do not exist in France. We some years ago made a demand for the introduction of political economy. It has since obtained a modest place in the course. It is now time to demand political and juridical instruction. Superior political instruction is in the most incomplete condition in France. In Germany, chairs of Public Law and Social Science are established in all the universities. The same is the case in Holland, Belgium, and Italy. M. Bluntschli occupies a chair of this kind at Heidelberg; can it be otherwise than that a professor of his talents should have rendered great services in so important a course? A free school of political science has been successfully organized in Paris, to fill the want of superior political instruction which is so apparent. It has been well said that France, more than any other country, ought to have professors charged with the duty of studying the conditions of the best government, and communicating the results of their labors to the public, for France overthrows its government and looks for a better one every twenty years. The scientific study of political questions would doubtless moderate this ardor for change, by showing to all how difficult the questions are. Lacking this, we have to be contented with plans of social organization improvised by journalists. In Belgium, the state has instituted a diploma for political sciences, which is a title of preference to administrative functions. As M. de Laveleye remarks, this is the only means of securing a sufficient contingent of assiduous pupils, and of diffusing the serious knowledge of political science through the country. The classes called superior must become worthy of their name. The movement will have to come from them and be spread through the totality. Moved and directed by them, popular suffrage will be, as has been said, useful by means of its sheer inertia, as the fly-wheel of a machine regulates and augments the force of the motor.

In the struggle of the nations for existence, the future will assure the triumph to the people who best comprehend that the highest intellectual, moral, and social culture is also the most necessary to its grandeur and power. The more democratic a nation is, the more it is inclined to be utilitarian, and yet it must not be wholly utilitarian. It wants an abundance of the moral and æsthetic. The true means of resolving the antinomies of universal suffrage is the widest possible distribution of the highest possible instruction. In this, society has only to follow the example of Nature, which causes unequal beings to rise from the equality of the mean. Of seeds under the same cultivation, those which are fruitful are sifted from those which are sterile. Two men, of nearly like intelligence, are working in a field; instruct

Belgian, sixty-seven per cent cited foreign notabilities of all kinds and from various places, and twenty per cent could name only Leopold I or Leopold II. Such were the insignificant effects of the Belgian law of 1842 on primary instruction.

them, and while one continues a laborer, the other may become a great light, a Laplace or a Faraday. Your equal instruction has freed the latent forces of superiority. The same is the case in the political field. Joined to a universal instruction, the effect of the equal right of suffrage will be, not to suppress the directive power of the whole, the superior authority, but to constitute it by an intelligent selection. While universal suffrage still leaves the door open for natural superiorities, these in their turn finally bring about a new equality with the level higher than before. This is the principal difference between the struggle for existence in the animal kingdom and competition in the human kingdom. The animal, which, by selection, has acquired a better dentary system, transmits its superiority to its own line, but not to other animals. It produces a kind of aristocracy. With mankind, however, a discovery made by one people is finally spread to other peoples. The error of demagogism and socialism consists in their not asking whether the present inequality, which raises certain superior individuals or classes above the crowd, when it is natural and not factitious, may not be the germ of an equal advancement in the future for all. True democracy aims at universal elevation, not universal depression, and to make power accessible to all superiorities, whoever may be the man or whatever class may have produced him. If our people receive such a superior instruction as we have proposed, we shall have Chambers composed of men versed in political economy, politics, history, and jurisprudence. We can not in this matter rely upon the spontaneity of individuals, any more than upon primary instruction. At present, the more easy classes are almost as deficient in true social and political knowledge as the masses. We complain of the incontestable mediocrity of our governments. It comes much more from the governors than from the governed. It is due to the defective education of those who have the duty of directing, to our poverty in superior men. But they say democracy is jealous. Envy is a vice of aristocracy as well as of democracy. Has democracy in France ever held out long against genius and talents when they have manifested themselves? Did it repel M. Thiers while he was living? Where to-day are any great political talents to which universal suffrage has refused its commission? Knowledge, justice, and truth, exercise a natural and inevitable ascendency over all peoples who are not composed of barbarians. Individuals and the masses only ask to obey whenever a natural authority exists and manifests itself. Wherever superior forces do not govern, it is because they do not exist; where ignoramuses make the law, it is most frequently because no men versed in politics are at hand. Where vice is the master, it is because the civic virtues described by Montesquieu are rare or have disappeared. If universal suffrage supposes men at the base capable of choosing, it still more supposes men at the top fit to be chosen.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

CANNIBALISM AS A CUSTOM.

BY A. ST. JOHNSTON.

THERE is a certain weird attractiveness about the subject of cannibalism, a grim fascination in its grisly horrors, that is not easily to be explained, but which, although few of us will admit it, most of us have experienced. Perhaps it is in subjective cannibalism alone that this uncanny attraction exists; objective cannibalism may not possess the same eerie charm. But the very fact that cannibalism either exists now, or ever existed, is, however, denied by some skeptical persons—mostly strict and rigid vegetarians, one would think—who argue that wild and natural races of men can not and do not lust for flesh. The fact remains the same.

It seems that this time-honored practice—crime, many unthinking and unjudicial people would call it, whose opinions have been formed without consideration of the relation of crime to custom—has, at different times, existed in almost every part of the earth. It seems to have lingered longest in the most beautiful regions of it—in Polynesia, namely, where the writer of this, but for a fortunate and timely warning, would himself have fallen a victim to the custom for which he has a feeling of respect, if not exactly of affection.

Our remote, possible forefathers themselves, the prehistoric cavemen of Europe in the Quaternary period, were addicted to this habit, which a pious feeling of respect for our ancestry should alone prevent us from characterizing as a crime. Evidences of their occasional little anthropophagistic failings, in the shape of scraped and chipped human bones which, besides being cooked, are broken in a manner too scientific and skillful to be the work of animals, are not infrequent, though it is believed by paleontologists that the custom was more of an exception than a rule. Animal food being plentiful at that time in these cold northern latitudes, the greatest incentive to cannibalism was wanting, and the very practice of it shows a tendency to epicurean indulgence and luxury that already (from a very long way off) pointed to the future extinction of their race. The ancient Irish, too, in more recent than Quaternary times, ate their own dead; and our own Saxon forefathers must have possessed a knowledge of the custom if they did not in early times actually practice it, as is shown by the Saxon word *manœta*, which occurs not infrequently in their literature.

Tales of cannibalism have also come down to us from classic times, which prove that the Greeks were at least not ignorant of it. Polyphemus in the "Odyssey" was a man-eater; and Herodotus tells us of a race of men, the Massagetæ, who ate their aged parents, going only a step further than the Feejeeans, who simply buried theirs alive. The Padæi, the father of history also tells us, ate their relatives when

they became incurable; and the Issedones did the same, resembling, in this particular, the Tupis of Brazil, who, when the *pajé* (chief) despaired of a man's recovery to health, killed and ate the invalid—a rough-and-ready method of proving that their respected chief and medicine-man could not be mistaken in his diagnosis of the case.

Our own hero-king, Richard Cœur-de-Lion, is said to have eaten human flesh during the Crusades; the popular belief of the time being that the cooked head of a Saracen had restored him to strength and activity from a bed of sickness. A verse of a contemporary ballad records this:

> "King Richard shall warrant
> There is no flesh so nourissant
> Unto an Englishman,
> Partridge, plover, heron, ne swan,
> Cow ne ox, sheep ne swine,
> As the head of a Sarazyne."

The probable causes for this strange variation from normal appetite are more numerous than would be supposed. Famine and the consequent insistent demands of hunger are the likeliest primary causes of this as well as of most things—the necessity for food being the first and most urgent incentive to action of all sorts. Modern stories of shipwreck, when the survivors have taken to the boats and all food is gone, or of travel in the barren wastes of Australia, show how naturally this means of prolonging life suggests itself to the minds of men ravenous with hunger, and from whom the thin cloak of civilization, with which we all hide the natural animal, has fallen away.

Enmity, hatred, and revenge are also excellent reasons for the origin of cannibalism, which would be almost as likely as hunger to have suggested it, as famine is not a constant factor in savage life, and we are led to suppose that hostility and rancor are. What more satisfactory method for the expression of detestation and contempt can be imagined, than that one should cook and calmly eat an enemy when one has slain him? The thing is then complete, *finis coronat opus*, the termination rounds and finishes the deed to a perfect whole; without this climax it were but half accomplished and entirely unsatisfactory. The happy and peaceful mind and the satisfied and replete body of a savage who has killed and cooked his foe, and eaten him, can easily be imagined, and they present a pleasant picture to the mind that is marred by no sense of incompleteness.

In many places, however, where food was plentiful, and where the people were otherwise amiable and gentle, and far advanced toward an admirable civilization—for instance, Mexico and Peru before the Spanish conquest—this custom of cannibalism prevailed, and to an extent that necessitated frequent wars for the providing of the requisite victims. Here the cause was of a more complex nature than the sim-

ple expression of hatred or contempt, or the supply of necessary food. The custom was closely associated with their religious observance; the eating of the flesh by the people, after the blood and quivering hearts of the victims had been offered to the deity, partook of the character of a sacrament as well as of a banquet. Prescott, in his "Conquest of Mexico," tells us, in his picturesque language, of the awful sacrifices to the war-god Huitzilopotchli, to whom hecatombs of human beings were usually sacrificed; and of the more epicurean and delicate Tezcatlepoca, who required but one victim, but insisted that that one must be "distinguished for his personal beauty, and without a blemish on his body."

"The most loathsome part of the story," Prescott goes on to say, "the manner in which the body of the sacrificed captive was disposed of, remains yet to be told. It was delivered to the warrior who had taken him in battle, and by him, after being dressed, was served up in an entertainment to his friends. This was not the coarse repast of famished cannibals, but a banquet teeming with delicious beverages and delicate viands, prepared with art, and attended by both sexes, who, as we shall see hereafter, conducted themselves with all the decorum of civilized life."

This shows that the custom of cannibalism in Mexico must be laid to the charge of religious feeling. The step is an easy and natural one that would lead a people who followed a strictly anthropomorphic worship to the consumption of the sacrifice which they were led to believe was acceptable to the gods. Prescott notes the same thing: "One detestable feature of the Aztec superstition, however, sunk it far below the Christian. This was its cannibalism, though in truth the Mexicans were not cannibals in the coarsest acceptance of the term. They did not feed on human flesh merely to satisfy a brutish appetite, but in obedience to their religion. Their repasts were made of the victims whose blood had been poured out at the altar of sacrifice. This is a distinction worthy of notice."

But with Aztecs, as with other peoples, the appalling appetite only grew by what it fed on, and a morbid and overmastering craving for this awful diet prompted them to frequent cannibal feasts, in which desire alone, and no religious ceremony, was the cause. Men having once tasted human flesh, like the man-eating tiger, always hanker after it with a strange and morbid pertinacity that seems almost unconquerable, as is shown in the case of Feejee, where the traditional and immemorial custom was habitually practiced (and is continued to this day in remoter parts) long after the introduction of pigs.

In the Feejee and other Polynesian islands, where there are no indigenous animals, cannibalism may be allowed, perhaps, some excuse. Man is by nature carnivorous as well as graminivorous, and the natural promptings of his physical wants would suggest the food that we, with our plethora of beef and mutton, too unadvisedly stigmatize as

unnatural and monstrous. It is not to be gainsaid that in Feejee the habit quite exceeded necessary requirements; but, without wishing to deny that fact, there is much, when the question is considered judicially, to palliate the offense in those parts. Until the introduction of pigs, toward the end of the eighteenth century, the only animal indigenous to Feejee and the adjacent islands was a rat. Birds and fish there certainly were, but no other animal, and the turning to profitable account of the body of an enemy slain in battle is, under those circumstances, perhaps very easily understood and condoned with. A friend of the writer's, who settled, very early in the history of that colony, on the banks of the Wai-ni-mala River, has related to him, with graphic simplicity, many deeds of horror that he has witnessed within very recent years; how *bakōlo*, as human flesh is called there, was sent from one chief to another, much as one gentleman sends game to another in our country; and how the sound of the death-drum—heard only once by the writer, but beaten then for himself—was so frequent in his district as to pass almost unnoticed by him.

The same excuse can not be urged in defense of the inhabitants of the West Coast of Africa, who, with a supply of animal food sufficient for all their wants, still indulge, much more frequently than is credited, in this strange flesh, even in those parts where for more than half a century the elevation and improvement of the native races have been the constant labor of the resident white traders, missionaries, and inhabitants. Hutchinson, who was for many years H. B. M. consul on the Gold Coast, writes in 1861, "People in England would scarcely believe that in these days, while I write, cannibalism is almost as rampant on the West Coast of Africa as it has ever been." He quotes, in support of this statement, from the report of the sixty-eighth anniversary of the Countess of Huntingdon's Connection in that colony: "Mr. Priddy, who is employed by the society, stated that the cruel and barbarous practice of cannibalism was still indulged in during the late war; and that he saw hampers of dried human flesh carried on the backs of men, upon which they intended to feast." Mr. Hutchinson goes on to say that "cannibalism exists in the Oman country, up the Cross River; and I am informed that the Boole tribe, who reside far interior to Corisco Bay, come down the river to get some of the sea-shore-dwelling people to make "chop" of them, because they are reputed to have a saltish, therefore a relishable flavor." This last statement only shows how taste varies in different quarters of the globe, for Feejeeans prefer a brown man to a white one on the very grounds that a white man is saltish, and therefore not so pleasant.

Until Mr. Hutchinson wrote it was not generally credited that the Western Africans were addicted to cannibalism, but his evidence is not to be doubted. "In 1859," he says, "human flesh was exposed as butcher's meat in the market at Duketown, Old Calabar." It almost seems that some religious grounds may actuate them, as the same writer

says: "In Brass (or the Mimbe country) cannibalism often occurs. Even within the last year a chief of that district, named Imamy, killed two of the Acreeka people before mentioned, who were sacrificed to the manes of his father. In Brass, as in Bonny, they eat all enemies taken in war; and they put forth, as a justification for this, that devouring the flesh of their enemies makes them brave." The account given by the same writer of the killing of a native for the purposes of cannibalism, of which he was an eye-witness, is most admirably graphic and striking, but it is, unfortunately, too long, if not too terrible, to quote in these pages.

Nor is cannibalism confined to the Ethiopian and Polynesian races alone; it is prevalent to an astonishing extent among the inhabitants of the Malayan Islands, Java, Sumatra, and Borneo. Some of the earliest voyagers to the Eastern seas came back with stories of how the people of those parts were man-eaters; but, however much credence their tales may have received at the time, they have been greatly doubted since. But Marsden and other writers prove that the statements of those early pioneers of travel and observation were entirely correct. Marsden, in his account of Sumatra, says that, although he had heard reports of the cannibal habits of some of the tribes, he had always discredited them until the truth of the statement was made entirely clear to him. He says that the Battas, one of the peoples of Sumatra, eat human flesh regularly, not to satisfy the cravings of hunger, but as a sort of ceremony to show their detestation of certain crimes by this most ignominious punishment, and as a savage display of revenge and insult to their unfortunate enemies. People killed or badly wounded by them in war are eaten, and the captured sold as slaves. These same Battas show a certain amount of culinary art in the preparation of this food, for they broil the flesh over a brisk fire, and flavor it with salt, lemon, and red pepper.

A friend of the writer's, who for more than forty years has been in the employment of the Dutch Government, bears personal witness to the prevalence of the custom in Sumatra up till recent times. He was once making scientific investigations in the interior of that island, and was being entertained in the most hospitable manner by the native rajah, or chief, of the place he was then in. A feast had been made to which he was bidden, and to which he went, taking his own native servant with him. The banquet had proceeded for some time without interruption, when at last, as crown of the feast, a beautiful brown roast joint was brought from the back of the house to the open, airy place where the repast was being held. This was cut up without remark and handed round, and the Dutch gentleman was on the point of eating his portion, having raised part of it to his lips, when his servant rushed forward and stopped him, saying, "Master, master, do not eat; it is a boy!" The chief, on being questioned, admitted, with no small pride at the extent of his hospitality, that, hearing that the white

man would feast with him, he had ordered a young boy to be killed and cooked in his honor, as the greatest delicacy obtainable, and that the joint before them was the best part, the thigh.

One is too apt to associate all sorts of ferocious qualities, cruelty, deceit, brutality, and inhospitality, with the mere word cannibal, thus stigmatizing with these vicious qualities whole races of people who do but retain this one among other ancient habits and customs; whereas in reality cannibals are much the same as other folk whose food is of a less barbarous nature. The very Caribs themselves, from the Latinized name of whom the word is probably derived, the arch-types of what cannibals should be, are described as possessing very different qualities. Their tribes, the remnants of which still linger in one of the West India isles, inhabited the northern part of South America and many of the Antilles before the arrival of the Spaniards, who destroyed almost the whole race. The description their conquerors give of them is more like that of a nation of lotos-eaters than of a sanguinary and ruthless people. "They are quiet, calm, and sedentary, and given up to idleness and day-dreams," say their historians, "but are well made and possess great powers of endurance." The testimony of the writer must be given on the same side; he has had the pleasure and privilege of knowing many cannibals, Feejeean, New Hebridean, Solomon-Islander, and others, and he has, on the whole, found them gentle, quiet, and inoffensive when not engaged in the practice and observance of the special principle that they uphold. It must be confessed, however, that he had not the same appreciation of their character upon the one occasion when he ran the narrowest chance of ministering to'what he then considered a very depraved and morbid appetite.

Early travelers in New Zealand always express astonishment, when they discover the cannibal propensities of the inhabitants, that so gentle and pleasant-mannered a people could become upon occasion such ferocious savages. Earle, who wrote a very readable, intelligent, and but little known account of the Maoris very early in the present century, speaks of the gentle manners and kindly ways of a New Zealand chief, whom afterward he discovered to be an inveterate cannibal. He relates that he visited the place where was cooking the body of a young slave girl that his friend had killed for the purpose. The head was severed from the body; the four quarters, with the principal bones removed, were compressed and packed into a small oven in the ground, and covered with earth. It was a case of unjustifiable cannibalism. No revenge was gratified by the deed, and no excuse could be made that the body was eaten to perfect their triumph. Earle says that he learned that the flesh takes many hours to cook, that it is very tough if not thoroughly cooked, but that it pulls in pieces, like a bit of blotting-paper, if well done. He continues that the victim was a handsome, pleasant-looking girl of sixteen, and one that he used frequently to see about the *pah*. To quote his own words:

"While listening to this frightful detail, we felt sick almost to fainting. We left Atoi" (the chief who had killed the girl), "and again strolled toward the spot where this disgusting feast was cooking. Not a native was now near it; a hot steam kept occasionally bursting from the smothered mass, and the same dog that we had seen take the head of the girl now crept from beneath the bushes and sneaked toward the village: to add to the gloominess of the whole, a large hawk rose heavily from the very spot where the poor victim had been cut in pieces. My friend and I sat gazing in this melancholy place; it was a lowering, gusty day, and the moaning of the wind through the bushes, as it swept round the hill on which we were, seemed in unison with our feelings."

Earle goes on to relate how he, and three other compatriots whom he summoned from the beach for the purpose, with the Englishman's usual impertinent interference and intolerance of customs differing from his own, determined to frustrate Atoi's intention. They together visited the hill where the flesh was cooking, and, destroying the oven, buried the remains in the earth. They found the heart put on one side for the special delectation of their constant friend and companion, Atoi. Earle was afterward good-humoredly told by the chief that their interference had been of no avail, as they had found the grave where the flesh had been buried, and opening it, soon after he and his friends had left, had finished cooking it and eaten it all. Earle argued long, and probably loudly, with the chief upon this question. Atoi asked him what they did with their thieves and runaways in England, and he told him, "Flog them or hang them." "Then," replied the Maori, "the only difference is that we eat them after we have killed them." The same chief told him that before the introduction of potatoes the people in the interior had nothing to eat but fern-roots and *kumera* (another edible root); fish they never had in the rivers, so that human flesh was the only sort that they ever partook of.

Another early traveler in New Zealand, Ellis, who had admirable opportunities for arriving at the real motive for this custom, tells us that the Maoris "eat the bodies of their enemies that they might *imbibe* their courage"; and that they exulted greatly at the banquet upon the body of a great chief, for they thought that they would thus obtain his valiant and daring spirit.

The eastern Polynesians made war chiefly for the purpose of obtaining bodies; hence, when clearing away the brushwood from a place where they expected to engage an enemy, they cheered each other with cries of "Clear away well, that we may kill and eat, and have a good feast to-day!" Their haughtiest threat was always, "We will kill and eat you!" and to be eaten was always the greatest dread of the exiled and conquered. Dr. Turner, in his most interesting work on Samoa, tells us that in New Caledonia "it was war, war, war, incessant war," and that all the good bodies were picked out from the

dead for the oven, while the bad were thrown away. If it was a woman, they ate only the arms and legs. On Maré they devoured all. Their appetite for human flesh was never satisfied. "'Do you mean to say that you will forbid us the *fish of the sea?* Why, these are our fish!' This is how they talked when you spoke against cannibalism."

When white men first landed in Australia the degraded natives received them with the greatest respect; they considered them to be the embodied spirits of their own dead. The Australians were, and still are, in the less-known northern parts, habitual cannibals, and always eat their own dead, for fear of wasting good provision. The black bodies being scalded, when being prepared for the oven, became white as the black cuticle came away. Thus, when Europeans first presented themselves to their astonished visions, they simply and reverently received them as the materialized spirits of their scalded ancestry.

Among the Indians of America the custom does not ever seem to have been a universal one, although it was general among certain tribes. Schoolcraft relates, in his great work on the "Indian Tribes," that the Sioux will eat the heart of an enemy, and that all the war party will try to get a mouthful, believing, with the Maoris, that they gain courage thereby. Back, too, in his "Arctic Expedition," tells of a Cree Indian who had killed and eaten his wife, daughter, and two sons, and would have killed the youngest, a boy, and fed upon him also, had he not come upon Back's encampment. But this can hardly be cited as a case typical of the cannibal instincts of that tribe, as it was only brought about by the direct famine. In Terra del Fuego the otherwise unreasoning natives show a spirit of intelligent economy by always eating, in times of great distress and want, the oldest women of the tribe, as being of much less value than their dogs, which they will not kill until all the grandmothers are consumed.

But one of the strangest phases of cannibal lore has yet to be touched upon, that, namely, with which all the greatest thaumaturgists and necromancers have been accused from the days of Hadrian, who is known to have sacrificed many young lives in the prosecution of his unholy inquiries, to our own. There is some foundation for this belief in the fact that for some of the deeper and wilder mysteries of the black art an innocent life had to be offered up, from the emanations of whose spilled blood the disembodied spirits of the invoked dead could materialize themselves, and answer the queries of those daring seekers who stopped at nothing to gain their unhallowed ends. It is related that the necromancers of Thessaly added the blood of infants to that of black lambs in their incantatory rites, that the evoked spirits would render themselves objective from the exhalations of the blood. In the present day Hayti is charged with being the home of a secret sect of devil-worshipers, the Voodoos, who practice most mysterious and impious solemnities, in which children are killed and offered up, and the bodies eaten by the adepts as part of the awful ceremonial. The Rus-

sian, Polish, and indeed all the Slav races, credit the Jews with the use of this rite to this day, and it is one of the many groundless reasons that they hold for the constant persecution of that race. They believe that at the Passover a child is killed and eaten with many dark and unheard-of observances. How thoroughly this absurd tradition is credited may be learned from the perusal of the recent criminal trials in Hungary.

It has been a pleasant task to the writer to attempt, in the above pages, to excuse the habit of cannibalism among its votaries. It is always unpleasant to remain silent when one hears a comrade unfairly aspersed; just so it has been with the writer when he has read or heard of the unjust estimation in which all cannibals are held. Many, in fact most writers improperly and wrongly charge cannibalism with being a morbid and unnatural appetite; in most cases it is nothing but the expression of a natural want. The demand and desire for human flesh would die out in nearly all places were the other flesh obtainable. In those regions where cannibalism still flourishes much may be done, and is done, by the example of the first white settlers—the traders—and the teaching of the missionary, but teaching and example alone will never suffice to remedy the evil; the root of the matter must be gone to; and, to cure it, many and varied animals that are fit for food must be introduced, when the thing will right itself.—*Gentleman's Magazine.*

STARVATION: ITS MORAL AND PHYSICAL EFFECTS.

By NATHANIEL EDWARD DAVIES, L. R. C. P.

THE recent case of cannibalism at sea opens up some curious questions as to the effects of fasting on the moral nature of man. To the superficial observer, death by starvation simply means a wasting of the body, a horrible agony, an increasing weakness, a lethargic state of the brain, and a sleep from which there is no awakening; but is this all that it means? While this is going on, let us consider whether or not the intellectual faculty, and with it the power of distinguishing right from wrong, is not also undergoing a process of wasting and death, even before that of the material part, for, however dangerous it may be to received opinions to associate the material nature of brain with the moral nature of our being, we are bound to do so to elucidate some of the facts connected with this case.

Reasoning by analogy, we find that, in many cases of bodily disease, the state of the mind is the first indicator of the mischief going on in the system. Take even such a simple thing as indigestion, which, as every one must know, is only a manifestation of a deranged stomach, and what do we find? That the lowness of spirits induced

by this affection may vary from slight dejection and ill-humor to the most extreme melancholy, sometimes inducing even a disposition to suicide. The sufferer misconceives every act of friendship, and exaggerates slight ailments into heavy grievances. So in starvation, the power of reason seems paralyzed and the intellectual faculty dazed really before the functions of the body suffer, or even the wasting of its tissue becomes extreme. Such being the case, the unfortunate individual is not accountable for his actions, even if they be criminal in character, long before death puts an end to his sufferings.

The most deep-rooted and powerful feelings of human nature—the love of a mother for her offspring—are perverted in cases of starvation, for we read in Josephus that during the siege of Jerusalem, under Titus, mothers ate their own children. A similar case is mentioned in Scripture as occurring during the famine in Samaria (2 Kings, vi, 29); if, in such a case, the intellectual faculty was not utterly disorganized, no amount of human agony would account for such complete perversion of nature.

Referring to this state, Aitken observes: "A depression of the nervous state is very early manifested in the impaired energy of all the vital functions, the weakened condition of the intellectual faculties and *moral feelings*, and diminution of the general sensibility." As vital activity and mental power are simply the manifestation of consumption of material, and, unless the supply of that material in the shape of food is kept up, a progressive waste of both must necessarily ensue; and that which depends for its manifestation on the material—that is, food—must be the first to go, that being in this case the intellectual faculty—the power of distinguishing right from wrong.

An old writer (Guianerius) says, "Anchorites, monks, and the rest of that superstitious rank, through immoderate fasting, have been frequently mad," showing that even in early times the fact was known and believed that want of food perverted the higher attributes of the mind before it destroyed life.

What are the symptoms of death from want of food, and how long can man subsist without solid or liquid nourishment? According to the experiments of Chossat, death takes place in from eight to eleven days, and after forty per cent of the weight of the body is consumed. Now, as this means more of certain tissues than others, it may be interesting to mention those that suffer most. The fat wastes ninety-three per cent of its weight; the blood, seventy-five; the spleen, seventy-one; the liver, fifty-two; the heart, forty-four; the bowels, forty-two; and the muscles, forty-two. On the other hand, the following parts waste much less: thus, the bones waste sixteen per cent; the eyes, ten; the skin, thirty-three; the lungs, twenty-two; and the nervous system, i. e., the nerves, *only two per cent.* The point worthy of attention is the almost total consumption of fat

before death takes place; in fact, death by starvation is really death by cold. As soon as the fat of the body goes—and fat is the principle that keeps up the heat—death takes place; the temperature of the body diminishes but little until the fat is consumed, then it rapidly falls.

Chossat—whose experiments on dumb animals are most painful to read—is of opinion that death from exposure to intense cold and death from starvation are one and the same, as, in the torpor of death from want of food, the application of warmth to the body immediately restored consciousness, showing that heat is closely related to the principle of life, as manifested through the nervous system in its more subtile sense.

The symptoms of starvation from want of food are—severe pain at the pit of the stomach, which is relieved on pressure; this subsides after a day or two, but is succeeded by a feeling of weakness and "sinking" in the same region; then an insatiable thirst supervenes, which, if water be withheld, thenceforth becomes the most distressing symptom. The countenance becomes pale and cadaverous, the eyes acquire a peculiarly wild and glistening stare, and general emaciation soon manifests itself. The body then exhales a peculiar fœtor, and the skin is covered with a brownish, dirty-looking, and offensive secretion. The bodily strength rapidly declines; the sufferer totters in walking, his voice becomes weak, and he is incapable of the least exertion. The mental powers exhibit a similar prostration: at first, there is usually a state of stupidity, which gradually increases to imbecility, so that it is difficult to induce the sufferer to make any effort for his own benefit, and on this a state of maniacal delirium frequently supervenes.

Before death takes place the body appears to be undergoing putrefaction, so that, though it seems to waste in one way, the power of the system to eliminate the effete products is paralyzed, and these, instead of being burned off, as they are when the proper nourishment of the tissues is going on, remain and decompose; in no other way can the fœtor during life be accounted for, and the rapid decomposition after death. This accounts also for the fact that cholera, fever, and blood-poisoning are so much more fatal in the badly-fed than they are in the well-to-do; the low state of the vitality induced prevents the elimination of the poison, and the sufferer dies, not by the virulence of the disease, but by his inability, through weakness, to throw it off. Pestilential diseases always follow in the wake of famine, and destroy more than perish from actual starvation.

To show how long life may be carried on with a very little food, the following case may be interesting: In February, 1862, a man thirty-six years of age was discovered in a stack near Morpeth dying from starvation. All attempts to rally him failed, and he ultimately died. He was an intelligent man, and had been editor and proprietor

of a penny journal called the "Falkirk Liberal." A diary was found in his possession containing entries of his condition from February 8th to 25th, from which it appeared that during the *seventeen* days he had twice tasted a piece of bread, but that for the last *thirteen* days he had been entirely without food. During the first *ten* days of the *thirteen* he was able to obtain water, but on the *eleventh* day he found his legs were useless, and he lost all motive power in his lower extremities, so that half his body appeared to be dead.

There is also the well-known case of the fat pig that was buried in its sty under thirty feet of the chalk of Dover Cliff for one hundred and sixty days, and which was dug out alive at the end of that time, reduced in weight from one hundred and sixty pounds to forty pounds, or no less than seventy-five per cent ("Transactions of the Linnæan Society," vol. xi, p. 411). The extraordinary prolongation of life in this case may be attributed to the retention of the *heat* of the body by the non-conducting power of the chalk, and to the retention of its moisture by the saturation of the air in its immediate vicinity, and restriction of its movements.

As might be expected, the old can live longer without food than the young. In youth, the growth of the body causes more rapid consumption of nourishment, and the supply and the waste are more quickly got rid of ; further than this, the nervous system, though more buoyant in youth, is less stable, so that the young perish quickly when the supply of food is cut off, from the want of sustaining power in the nervous system. This was illustrated in the recent case of cannibalism, the boy being in a dying state, when the men, so far as their muscular power was concerned, were strong enough to accomplish the terrible deed they did.

In the case of the Welsh fasting girl, death took place after deprivation of food for eight days. During the first few days she was cheerful, but later on it was found she could not be kept warm ; she then lapsed into a state of torpor, from which she could not be roused, and died.

Four men and a boy were imprisoned in a mine from April 11th to April 19th ; they had access to water, but no food, between those dates. When liberated, they all recovered ; the damp atmosphere and their access to water being powerful factors in their aid.

Another curious fact to be observed in those who recover after prolonged starvation is their unwillingness to be questioned on the subject, and their inability to give any coherent version of their sufferings and feelings, showing plainly that the mental power was too torpid to take impressions at the time. In the recent case of cannibalism, their suffering was aggravated by intense thirst, but they seem to have been able to give a graphic account of the horrors of their situation, which is not usually the case.

The history of starvation points to this fact, that the moral sense

dies before the physical being; and some interesting intelligence may be gathered by a study of this subject in its broadest basis as a national question, where it relates to the intellectual and social qualities of race in ill-fed and well-fed countries.—*Health.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XL.—COUNT RUMFORD'S SUBSTITUTE FOR TEA.

TAKE eight parts by weight (say ounces) of meal (Rumford says "wheat or rye-meal" and I add, or oatmeal), and one part of butter. Melt the butter in a clean *iron* frying-pan, and when thus melted sprinkle the meal into it; stir the whole briskly with a broad wooden spoon or spatula till the butter has disappeared and the meal is of a uniform brown color like roasted coffee, great care being taken to prevent burning on the bottom of the pan. About half an ounce of this roasted meal boiled in a pint of water, and seasoned with salt, pepper, and vinegar, forms "burned soup," much used by the wood-cutters of Bavaria, who work in the mountains far away from any habitations. Their provisions for a week (the time they commonly remain in the mountains) consist of a large loaf of rye-bread (which, as it does not so soon grow dry and stale as wheaten bread, is always preferred to it); a linen bag, containing a small quantity of roasted meal, prepared as above; another small bag of salt, and a small wooden box containing some pounded black pepper; and sometimes, but not often, a small bottle of vinegar; but *black pepper* is an ingredient never omitted. The rye-bread, which eaten alone or with cold water would be very hard fare, is rendered palatable and satisfactory, Rumford thinks also more wholesome and nutritious, by the help of a bowl of hot soup, so easily prepared from the roasted meal. He tells us that this is not only used by the wood-cutters, but that it is also the common breakfast of the Bavarian peasant, and adds that "it is infinitely preferable, in all respects, to that most pernicious wash, *tea*, with which the lower classes of the inhabitants of Great Britain drench their stomachs and ruin their constitutions." He adds that, "when tea is taken with a sufficient quantity of sugar and good cream, and with a large quantity of bread-and-butter, or with toast and boiled eggs, and, above all, *when it is not drunk too hot*, it is certainly less unwholesome; but a simple infusion of this drug, drunk boiling hot, as the poor usually take it, is certainly a poison, which, though it is sometimes slow in its operation, never fails to produce fatal effects, even in the strongest constitutions, where the free use of it is continued for a considerable length of time."

This may appear to many a very strong condemnation of their favorite beverage; nevertheless, I am satisfied that it is perfectly sound. This is not an opinion hastily adopted, but a conclusion based upon many observations, extending over a long period of years, and confirmed by experiments made upon myself.

The "Pall Mall Gazette" of August 7th says, "There is balm for tea-drinkers in one of Mr. Mattieu Williams's 'Science Notes' in the 'Gentleman's Magazine.'" This is true to a certain extent. I referred to the Chinese as habitual drinkers of boiled water, and suggest that this may explain their comparative immunity from cholera, where all the other conditions for a raging epidemic are fulfilled. It is the boiling of the water, not the infusion of tea-leaves therein, to which I attribute the destruction of the germs of infection.

In the note which follows, I proposed an infusion of fried or toasted bread-crumbs, oatmeal, maize, wheat, barley, malt, etc., as a substitute for the tea, the deep color of the infusion (poured off from the grounds in this case) serving to certify the boiling of the water. Rumford's burned soup, taken habitually at breakfast or other meals, would answer the same purpose, with the further advantage to poor people of being, to a certain extent, a nutritious soup as well as a beverage. All that is nutritious in porter is in this, minus the alcoholic drug and its vile companion, the fusel-oil.

The experience of every confirmed tea-drinker, when soundly interpreted, supplies condemnation of the beverage; the plea commonly and blindly urged on its behalf being, when understood, an eloquent expression of such condemnation. "It is so refreshing"; "I am fit for nothing when tea-time comes round until I have had my tea, and then I am fit for anything." The "fit for nothing" state comes on at five P. M., when the drug is taken at the orthodox time, or even in the early morning, in the case of those who are accustomed to have a cup of tea brought to their bedside before rising. With blindness still more profound, some will plead for tea by telling that by its aid one can sit up all night long at brain-work without feeling sleepy, provided ample supplies of the infusion are taken from time to time.

It is unquestionably true that such may be done; that the tea-drinker is languid and weary at tea-time, whatever be the hour, and that the refreshment produced by "the cup that cheers" and is *said* not to inebriate, is almost instantaneous.

What is the true significance of these facts?

The refreshment is certainly not due to nutrition, not to the rebuilding of any worn-out or exhausted organic tissue. The total quantity of material conveyed from the tea-leaves into the water is ridiculously too small for the performance of any such nutritive function; and, besides this, the action is far too rapid, there is not sufficient time for the conversion of even that minute quantity into organized working tissue. The action can not be that of a food, but is purely

and simply that of a stimulating or irritant drug, acting directly and abnormally on the nervous system.

The five-o'clock lassitude and craving are neither more nor less than the reaction induced by the habitual abnormal stimulation ; or otherwise, and quite fairly, stated, it is the outward symptom of a diseased condition of brain produced by the action of a drug ; it may be but a mild form of disease, but it is truly a disease nevertheless.

The active principle which produces this result is the crystalline alkaloid, the *theine*, a compound belonging to the same class as strychnine and a number of similar vegetable poisons. These, when diluted, act medicinally, that is, produce disturbance of normal functions as the tea does, and, like theine, most of them act specially on the nervous system ; when concentrated they are dreadful poisons, very small doses producing death.

The non-tea-drinker does not suffer any of these five-o'clock symptoms, and, if otherwise in sound health, remains in steady working condition until his day's work is ended and the time for rest and sleep arrives. But the habitual victim of any kind of drug or disturber of normal functions acquires a diseased condition, displayed by the loss of vitality or other deviation from normal condition, which is temporarily relieved by the usual dose of the drug, but only in such wise as to generate a renewed craving. I include in this general statement all the vice-drugs (to coin a general name), such as alcohol, opium, tobacco (whether smoked, chewed, or snuffed), arsenic, hasheesh, betel-nut, coca-leaf, thorn-apple, Siberian fungus, maté, etc., all of which are excessively "refreshing" to their victims, and of which the use may be, and has been, defended by the same arguments as those used by the advocates of habitual tea-drinking.

Speaking generally, the reaction or residual effect of these on the system is nearly the opposite of that of their immediate effect, and thus larger and larger doses are demanded to bring the system to its normal condition. The non-tea-drinker or moderate drinker is kept awake by a cup of tea or coffee taken late at night, while the hard drinker of these beverages scarcely feels any effect, especially if accustomed to take it at that time.

The practice of taking tea or coffee by students, in order to work at night, is downright madness, especially when preparing for an examination. More than half of the cases of break-down, loss of memory, fainting, etc., which occur during severe examinations, and far more frequently than is commonly known, are due to this.

I frequently hear of promising students who have thus failed ; and, on inquiry, have learned—in almost every instance—that the victim has previously drugged himself with tea or coffee. Sleep is the rest of the brain ; to rob the hard-worked brain of its necessary rest is cerebral suicide.

My old friend, the late Thomas Wright, was a victim of this ter-

rible folly. He undertook the translation of the "Life of Julius Cæsar," by Napoleon III, and to do it in a cruelly short time. He fulfilled his contract by sitting up several nights successively by the aid of strong tea or coffee (I forget which). I saw him shortly afterward. In a few weeks he had aged alarmingly, and become quite bald, his brain gave way and never recovered. There was but little difference between his age and mine, and but for this dreadful cerebral strain, rendered possible only by the alkaloid (for otherwise he would have fallen to sleep over his work, and thereby saved his life), he might still be amusing and instructing thousands of readers by fresh volumes of popularized archæological research.

I need scarcely add that all I have said above applies to coffee as to tea, though not so seriously *in this country*. The active alkaloid is the same in both, but tea contains weight for weight about three times as much as coffee. In this country we commonly use about fifty per cent more coffee than tea to each given measure of water, and thus get about half as much alkaloid. On the Continent they use about double our quantity (this is the true secret of "coffee as in France"), and thus produce as potent an infusion as our tea.

The above remarks are exclusively applied to the *habitual* use of these stimulants. As medicines, used occasionally and judiciously, they are invaluable, provided always that they are not used as ordinary beverages. In Italy, Greece, and some parts of the East, it is customary, when anybody feels ill, with indefinite symptoms, to send to the druggist for a dose of tea. From what I have seen of its action on non-tea-drinkers, it appears to be specially potent in arresting the premonitory symptoms of fever, the fever-headache, etc.

XLI.—AUTHORITIES ON TEA AND COFFEE.

Since the publication of my last I have been reminded of the high authorities who have defended the use of the alkaloids, and more particularly of Liebig's theory, or the theory commonly attributed to Liebig, but which is Lehmann's, published in Liebig's "Annalen," Volume LXXXVII, and adopted and advocated by Liebig with his usual ability.

Lehmann watched *for some weeks* the effects of coffee upon two persons in good health. He found that it retarded the waste of the tissues of the body, that the proportion of phosphoric acid and of urea excreted by the kidneys was diminished by the action of the coffee, the diet being in all other respects the same. Pure caffeine (which is the same as theine) produced a similar effect; the aromatic oil of the coffee, given separately, was found to exert stimulating effect on the nervous system.

Johnstone ("Chemistry of Common Life"), closely following Liebig, and referring to the researches of Lehmann, says: "The waste of the body is lessened by the introduction of theine into the stomach

—that is, by the use of tea. And, if the waste be lessened, the necessity for food to repair it will be lessened in an equal proportion. In other words, by the consumption of a certain quantity of tea, the health and strength of the body will be maintained in an equal degree upon a smaller quantity of ordinary food. Tea, therefore, saves food —stands to a certain extent in the place of food—while, at the same time, it soothes the body and enlivens the mind."

He proceeds to say that "in the old and infirm it serves also another purpose. In the life of most persons a period arrives when the stomach no longer digests enough of the ordinary elements of food to make up for the natural daily waste of the bodily substance. The size and weight of the body, therefore, begin to diminish more or less perceptibly. At this period tea comes in as a medicine to arrest the waste, to keep the body from falling away so fast, and thus to enable the less energetic powers of digestion still to supply as much as is needed to repair the wear and tear of the solid tissues." No wonder, therefore, says he, "that the aged female, who has barely enough income to buy what are called the common necessaries of life, should yet spend a portion of her small gains in purchasing her ounce of tea. She can live quite as well on less common food when she takes her tea along with it; while she feels lighter at the same time, more cheerful, and fitter for her work, because of the indulgence."

All this is based upon the researches of Lehmann and others, who measured the work of the vital furnace by the quantity of ashes produced—the urea and phosphoric acid excreted. But there is also another method of measuring the same, that of collecting the expired breath and determining the quantity of carbonic acid given off by combustion. This method is imperfect, inasmuch as it only measures a portion of the carbonic acid which is given off. The skin is also a respiratory organ, co-operating with the lungs in evolving carbonic acid.

Dr. Edward Smith adopted this method of measuring the respired carbonic acid. His results were first published in "The Philosophical Transactions" of 1859, and again in Chapter XXXV of his volume on "Food," "International Scientific Series."

After stating, in the latter, the details of the experiments, which include depth of respiration as well as amount of carbonic acid respired, he says: "Hence it was proved beyond all doubt that tea is a most powerful respiratory excitant. As it causes an evolution of carbon greatly beyond that which it supplies, it follows that it must powerfully promote those vital changes in food which ultimately produce the carbonic acid to be evolved. Instead, therefore, of supplying nutritive matter, it causes the assimilation and transformation of other foods."

Now, note the following practical conclusions, which I quote in Dr. Smith's own words, but take the liberty of rendering in italics those

passages that I wish the reader to specially compare with the preceding quotations from Johnstone: "In reference to nutrition, we may say that *tea increases waste*, since it promotes the transformation of food without supplying nutriment, and increases the loss of heat without supplying fuel, and *it is therefore especially adapted to the wants of those who usually eat too much*, and after a full meal, when the process of assimilation should be quickened, but *is less adapted to the poor and ill-fed*, and during fasting." He tells us very positively that "to take tea before a meal is as absurd as not to take it after a meal, unless the system be at all times replete with nutritive material." And, again, "Our experiments have sufficed to show how tea may be *injurious if taken with deficient food, and thereby exaggerate the evils of the poor*"; and, again: "The conclusions at which we arrived after our researches in 1858 were that tea should not be taken without food, unless after a full meal; or with insufficient food; or by the young or very feeble; and that *its essential action is to waste the system or consume food*, by promoting vital action which it does not support, and they have not been disproved by any subsequent scientific researches."

This final assertion may be true, and to those who "go in for the last thing out," the latest novelty or fashion in science, literature, and millinery, the absence of any refutation of later date is quite enough.

But how about the previous scientific researches of Lehmann, who, on all such subjects, is about the highest authority that can be quoted? His three volumes on "Physiological Chemistry," translated and republished by the Cavendish Society, stand pre-eminent as the best-written, most condensed, and complete work on the subject, and his original researches constitute a lifetime's work, not of mere random change-ringing among the elements of obscure and insignificant organic compounds, but of judiciously selected chemical work, having definite philosophical aims and objects.

It is evident from the passages I have emphatically quoted that Dr. Smith flatly contradicts Lehmann, and arrives at directly contradictory physiological results and practical inferences.

Are we, therefore, to conclude that he has blundered in his analysis, or that Lehmann has done so?

On carefully comparing the two sets of investigations, I conclude that there is no necessary contradiction *in the facts;* that both may be, and in all probability are, quite correct as regards their chemical results; but that Dr. Smith has only attacked half the problem, while Lehmann has grasped the whole.

All the popular stimulants, refreshing drugs, and "pick-me-ups" have two distinct and opposite actions—an immediate exaltation which lasts for a certain period, varying with the drug and the constitution of its victim, and a subsequent depression proportionate to the primary exaltation, but, as I believe, always exceeding it either in

duration or intensity, or both, thus giving as a net or mean result a loss of vitality.

Dr. Smith's experiments only measured a partial result (the carbonic acid exhaled from the lungs without that from the skin) *of the first stage*, the period of exaltation. His experiments were extended to 50 minutes, 71 minutes, 65 minutes, and in one case to 1 hour and 50 minutes. It is worthy of note that in Experiment 1 were 100 grains of black tea, which were given to two persons, and the time of the experiment was 50 and 71 minutes; the average increase was 71 and 68 cubic inches per minute, while in No. 6, with the same dose and the carbonic acid collected during 1 hour and 50 minutes, the average increase per minute was only 47·5 cubic inches. These indicate the decline of the exaltation, and the curves on his diagrams show the same. His coffee results were similar.

We all know that the "refreshing" action often extends over a considerable period. My own experiments on myself show that this is three or four hours, while that of beer or wine is less than one hour (moderate doses in each case).

I have tested this by walking measured distances after taking the stimulant and comparing with my walking powers when taking no other beverage than cold water. The duration of the tea stimulation has been also measured (painfully so) by the duration of sleeplessness when female seduction has led me to drink tea late in the evening. The duration of coffee about one third less than tea.

Lehmann's experiments, extending over weeks (days instead of minutes), measured the whole effect of the alkaloid and oil of the coffee, during both the periods of exaltation and depression, and therefore supplied a mean or total result which accords with ordinary every-day experience. It is well known that the pot of tea of the poor needle-woman subdues the natural craving for food; the habitual smoker claims the same merit for his pipe, and the chewer for his quid. Wonderful stories are told of the long abstinence of the drinkers of maté, chewers of betel-nut, Siberian fungus, coca-leaf, and pepper-wort, and the smokers and eaters of hasheesh, etc. Not only is the sense of hunger allayed, but less food is demanded for sustaining life.

It is a curious fact that similar effects should be produced and similar advantages claimed for the use of a drug which is totally different in its other chemical properties and relations. "White arsenic," or arsenious acid, is the oxide of a metal, and far as the poles asunder from the alkaloids, alcohols, and aromatic resins, in chemical classification. But it does check the waste of the tissues, and is eaten by the Styrians and others with physiological effects curiously resembling those of its chemical antipodeans above named. Foremost among these physiological effects is that of "making the food appear to go further."

It is strange that any physiologist should claim this diminution of the normal waste and renewal of tissue as a merit, seeing that life itself is the product of such change, and death the result of its cessation. But, in the eagerness that has been displayed to justify existing indulgences, this claim has been extensively made by men who ought to know better than admit such a plea.

I speak, of course, of the *habitual* use of such drugs, not of their occasional medicinal use. The waste of the body may be going on with killing rapidity, as in fever, and then such medicines may save life, provided always that the body has not become "tolerant" of or partially insensible to, them by daily usage. I once watched a dangerous case of typhoid fever. Acting under the instructions of skillful medical attendants, and aided by a clinical thermometer and a seconds-watch, I so applied small doses of brandy at short intervals as to keep down both pulse and temperature within the limits of fatal combustion. The patient had scarcely tasted alcohol before this, and therefore it exerted its maximum efficacy. I was surprised at the certain response of both pulse and temperature to this most valuable medicine and most pernicious beverage.

The argument that has been the most industriously urged in favor of all the vice-drugs, and each in its turn, is that miserable apology that has been made for every folly, every vice, every political abuse, every social crime (such as slavery, polygamy, etc.), when the time has arrived for reformation. I can not condescend to seriously argue against it, but merely state the fact that the widely diffused practice of using some kind of stimulating drug has been claimed as a sufficient proof of the necessity or advantage of such practice. I leave my readers to bestow on such a plea the treatment they may think it deserves. Those who believe that a rational being should have rational grounds for his conduct will treat this customary refuge of blind conservatism as I do.—*Knowledge.*

THE PERILS OF RAPID CIVILIZATION.

BY CHARLES F. WITHINGTON, M. D.

THAT civilization exerts upon the older societies of the world an influence which is on the whole favorable to physical perfection and longevity has been abundantly shown. While certain forms of disease, more particularly those affecting the nervous system, are increasing in frequency as a result of the increased demands upon the workers in our large cities, yet there is no question that a more than countervailing influence is exerted by the greater knowledge of sanitary science and the increased resistant power which modern civiliza-

tion has conferred on mankind. The prolonged "expectation of life" which tables of life-insurance exhibit is of itself sufficient to demonstrate this fact; and much has been written to show in what the elements of this gain consist.

On the other hand, however, there is reason to believe that, for the newer races, the immediate effect of a contact with civilization has been disastrous. The rapid growth out from barbarism is not always a safe or a simple process. The birth of "a nation in a day" is not devoid of grave perils. A brief consideration of the physical effects of civilization upon primitive peoples is the object of this paper. First, as to the facts. There are upon our globe numerous barbarous and semi-barbarous tribes who have never come much in contact with the world's progress, and we have no reason to believe that these peoples are in any degree dying out. Nature keeps them, like the lower animals which the hunter has never molested, in full and probably somewhat increasing ranks. It is obvious that figures are very difficult to obtain regarding such races—almost as difficult as in respect to the dumb animals with which we have compared them. Both alike undergo reduction from the attacks of their natural enemies, and from famine, disease, flood, fire, and hurricane. Yet no general law of survival of the fittest sweeps these races entirely from the earth, or even greatly reduces their numbers. This law may and probably does have effect within the tribes themselves, bringing the strongest to the front and leaving the weakest in the rear, but it does not operate against the existence of the tribe as a whole so long as there is no contact or conflict with a superior race, any more than it operates against the increase of the human species as a whole. In China and Japan, almost alone of such peoples, we have means of judging of the population at different intervals; and, while there is room for doubt as to the absolute accuracy of the census, yet the figures are so numerous and the general tendency so uniform that it may be taken to show with certainty an increase within the last few centuries almost equal to that of England. For instance, we have statements of the population of China at many periods within the last five hundred years, in part from native and in part from European authorities, showing an increase of from eight to ten hundred per cent in the number of inhabitants.* This enormous gain has been in spite of many and terrible famines, of sanguinary wars, and of extensive infanticide. It is reasonable to suppose that in other lands, of which we have no figures to inform us, there has also been a like fertility, and that savages have a vigor of stock which has led to increase and multiplication on a scale not greatly different from that of our own race.

When, however, barbarous peoples come in contact with a higher civilization, they almost invariably undergo a decay pretty nearly

* See a list of various censuses in the "Journal of the Statistical Society," vol. xx, p. 51.

proportional to the intimacy of the contact, or rather to the readiness with which they endeavor to conform themselves to the manners of their new neighbors. Here is an important point. There is no mysterious influence, no "blight," caused by civilization. There is much loose talk about barbarians "melting away" before the light of progress. It may do for the poet to speak of the withering breath of civilization as blasting the child of Nature, but the real cause of the depressing effect of our civilization upon the savage lies in himself, and in his sudden attempt to assimilate what is foreign to the whole tenor of his personal habits, confirmed as they are by centuries of inherited experience. The instances, plentiful enough, of race-decay following civilization, are all in peoples in whom circumstances have led to a sudden and unnatural conformity with the manners of a stronger and more advanced nation. This has occurred generally where the savages have been brought in contact either with a conquering people or with missionaries, the latter cause operating for the most part only when the barbarous tribe was small and the Christianizing influence therefore especially strong, as in the Sandwich Islands. In one notable case the method of contact has been by the barbarians themselves becoming conquerors. Let us examine this latter instance first. The earliest authentic historical record of the Goths as a people shows them in the latter half of the third century living north of the Danube. For a hundred years they had very little connection with any more civilized nation. Then, on the appearance of the Huns in 376, a part of the nation (later to be known as the Visigoths) advanced south of the Danube, the eastern division of the tribe, or Ostrogoths, remaining on the northern side of the river, and mingling with the invading Huns. The latter portion, therefore, were not brought into connection with either branch of the Roman Empire, while the western Goths, gradually adopting a form of the Christian faith, and being enlisted in the Roman armies, were slowly being acted upon by southern civilization. Of course, the effect of the change was much less marked than that of the contact of barbarism with modern civilization; still, undoubtedly, a considerable modification of the character and customs of the western Goths was made, and it occurred gradually enough to diminish its shock. For many years they fought, alternately under and against the eagles, and when finally, under Alaric, their power became supreme in Italy, early in the fifth century, they retired into Gaul very soon after the first sack of Rome. Afterward, though they joined with the Italians against the combined forces of the Huns and Ostrogoths, yet their association was mostly with the provincial representatives of the Roman civilization, and they gradually assumed their permanent position in Aquitania and Spain, where they left their impress as a constituent part of the Provence nation.*

In marked contrast with this was the contact of the Ostrogoths

* Gibbon's "Decline and Fall," chapter xxxi, *et seq.*

with Roman civilization, it occurring more suddenly and lasting longer. Joined in fortunes with the Huns, they shared in the terrific defeat of Attila at Châlons in 451. At just about this time Theodoric, destined to become their great leader, was born. Brought up at Constantinople, as a hostage, he was imbued with the best culture of the Eastern Empire. In 489 he led his people into Italy, and, overcoming the resistance of a usurping king, speedily made himself master of that country. Two hundred thousand men, with their wives and children, were settled in Italy. For thirty-three years they mingled as conquerors in the current of a new and untried civilization. They conformed themselves to the Roman administration and policy. So far from destroying the monuments of art, they took measures for their restoration and preservation. Agriculture and the arts of peace revived, and Italy almost regained the prosperity of her palmiest days. The "barbarian" set himself and his soldiers to do police duty for the Roman officers of law and government, who were retained in their titles and functions. An Arian himself, he respected and tolerated the Catholic faith.* In fact, we have here a most marked instance of a people in the position of conquerors adopting, in a generation, the civilization of their vanquished foes. And what is the result? Their wise and beneficent king died in 526. In the next twenty-five years the prosperous and strong nation rapidly declines in power and numbers. Belisarius and his successor Narses overcome them, now by strategy, now by force, until, in 553, their last king is slain, and the nation of the Ostrogoths becomes extinct.†

We can only allude, in passing, to the Huns, who never fairly reached the seat of the Roman power in Italy, though they were sought in alliance by the timorous emperors—and it is remarkable, in view of their vast numbers, how completely they disappear from history, within twenty years of their first aggressions on Roman territory, in the defeat and death of their one great chief.

The Vandals demand a word of attention. Though they appear in history as early as the second century, they are peaceably disposed of and remain quiet in Pannonia till the beginning of the fifth century, when they attack Gaul; thence they overrun Spain, to be displaced by the western Goths, and cross to Africa. Each of the barbarian races seems to have had its one great man, and the Vandals had their Genseric. In Africa they numbered from fifty thousand to eighty thousand men, and took their turn at sacking the Imperial City. For fourteen days they ravaged it. But it was only a foray, not a conquest. They did not stay among the Italians, as the Ostrogoths had done. Early in the following century Belisarius had slain their last king. A few of their soldiers were enlisted to fight in the Persian wars, but the sacrifice of these is, in the words of Gibbon, "insufficient to explain the fate of a nation whose numbers, before a short and

* *Vide* Gibbon, chapter xxxix. † Ibid., chapter xliii.

bloodless war, amounted to more than six hundred thousand persons." *

All these races, except the Huns, were of Teutonic or kindred lineage. What we wish particularly to call attention to is, that while they, powerful in numbers, vigorous in body, and indomitable in spirit, under the influence of the old civilization of the South speedily became extinct as races, and, except in the single case of the Visigoths, even left no visible impress of themselves upon a subsequent people, while, in fact, they dropped out of existence; yet, on the other hand, similar nations, coming also from Northern Europe, of the Teutonic family, driven by the same impulse for adventure and conquest, but going instead among the barbarous Britons, with whom they were amalgamated, became, by a slow, a natural process of evolution, the foremost nation of the globe.

These instances from antiquity are sufficiently striking. But it is in modern times only that we can really study to advantage the effect of a sudden civilization upon barbarians. In the cases thus far considered we can judge of effects only when they are extreme, as leading to the extinction of a race. There is no means of estimating those lesser changes which are best measured by the aid of the census. Nor is it possible at this distance of time to appreciate fully those different elements of deterioration which can be observed in contemporary races. Hence we pass to some of the more recent illustrations of the point under discussion.

The present century has witnessed in the Sandwich Islands what is probably the most remarkable instance of civilization in the history of the world. A little more than one hundred years ago Captain Cook was killed by the natives, who, though not cannibals, were as degraded as any tribe on the face of the earth. The story of this people is too familiar to need repetition. The first missionary visited the islands in 1820. In 1853, just one generation later, the American Board of Foreign Missions declared that the people were Christianized, and withdrew its support from the churches. Since that time they have not only maintained themselves, but are supporting missionaries in Polynesia. The formation of a constitutional government, the negotiation of treaties, the development of a system of education, the grateful and graceful contributions made in aid of the United States Government during our late civil war, all have happened within the memory of middle-aged men. Mr. Charles Nordhoff, who is certainly not prejudiced in favor of the missionaries, says † that they "have eradicated the grosser crimes of murder and theft so completely that . . . people leave their houses open all day and unlocked all night, without thought of theft; and there is not a country in the world where the stranger may travel in such absolute safety as in these islands. In 1880 there were two

* *Loc. cit.*, chapter xli.

† "Northern California, Oregon, and the Sandwich Islands," p. 24.

hundred and ten schools, having an attendance of over seven thousand children." Even in 1873 Mr. Nordhoff said, "The natives of these islands are, there is reason to believe, the most generally educated people in the world." Yet, with the phenomenal advance in intellect and morals which this race has made, there is a most rapid and melancholy decay of their physical organization. With an abundance of schools and churches, there are every year fewer scholars and worshipers; with an admirable system of government, there are constantly becoming fewer to govern.

The successive census returns tell this sad story: In 1832 the inhabitants of the islands were 130,313; in 1836, 108,579; in 1850, 84,165; in 1860, 69,700; in 1866, 62,959; in 1872, 56,897; in 1878, 57,985.* And even this seeming arrest, shown by the last census, in the process of decay in the native race, is not real; for during the last six years the Hawaiian population decreased over four thousand, the total gain being caused by an increase of foreigners to the extent of over five thousand. The Government, in a frantic effort to save itself from extinction, is importing immigrants: during the two years ending in 1880 it introduced over nine hundred Portuguese from the Madeira Islands, and more than eleven hundred Polynesians from the Gilbert Islands. Besides these, many Chinese have come. We are told, moreover, that the physical type of the natives has deteriorated; that the great stature and forms noted by the early visitors to the islands have passed away.

The history of the Hawaiians for the last sixty years might be almost condensed into three words—Christianization, civilization, extermination.

In 1860 Mr. F. D. Fenton was instructed by the New Zealand Government to prepare a statement with reference to the decay of the aboriginal Maori race, together with an investigation into its causes. His report, which is contained in Volume XXIII of the "Journal of the Statistical Society," shows a marked decrease, amounting to nineteen and a half per cent in the fourteen years from 1844 to 1858. This loss of numbers occurred in the absence of most of the causes commonly assigned for the decay of races. Mr. Fenton shows that all the tribes occupied healthful situations, that the climate was benign, and that the fertility of the soil was such as to secure an abundance of nutritious food. In fact, while the United States was increasing at the rate of thirty-five per cent every decade, this ancient race was diminishing at the rate of fourteen per cent every ten years; and, so far as the natural advantages of soil and climate are concerned, there seems to be little to choose between the two countries. Moreover, this deterioration was of recent origin. It was first noticed in 1841 by Bishop Broughton, and the Maories themselves say that it has commenced within the recollection of the present generation. The fact that there are more males

* Mrs. Judd, "Honolulu," *vide* Appendix, by Albert Judd.

than females disposes of the theory that war is the cause of the decrease; and infanticide, which chiefly affected the females, has ceased since 1836. Small-pox has now visited the island; measles may be said to be the only epidemic disease brought by the Europeans, and this did not appear till 1853. There is very little intoxication, and the "vice-diseases" are said to take a very mild type. Finally, that some radical cause is in operation is shown by the fact that actually fewer children are born than before the colonization of the island, and that, while the half-breed families are large, the native families are small, and the infantile mortality is very great. In view of the wide extent of country over which this process is going on, the author sees nothing to expect but the speedy extinction of the race.

The history of the American Indians should obviously not be omitted in this consideration. Unfortunately, figures here are unreliable. Estimate necessarily replaced enumeration regarding the aboriginal population when the whites landed, and has continued in large degree to do so since. Doubtless terror and perhaps vain-glory added something to the report of the numbers of the savages whom our ancestors fought and vanquished. But we have some ground for a comparative estimate of the native population. In 1822 a census was taken by the Government of the Indians east of the Mississippi, with reference to the removal of them which was then contemplated. According to this enumeration, they were 120,000. Bancroft's estimate of the Eastern Indians in the first half of the seventeenth century is 180,000. This would indicate a diminution of thirty-three per cent in two centuries, during which the Indians had been more or less in contact with the whites, and during the latter part of which they had doubtless begun to modify their way of living in accordance with the customs of their neighbors. It was about this time that the policy of removal to reservations beyond the Mississippi was inaugurated. A few of the Cherokees had accepted a reservation in Arkansas in 1817, but it was not till 1828 that the majority of them left Georgia, and the emigration continued through the following ten years. In 1838, 81,000 had been removed, 39,000 remaining east of the Mississippi.* In 1853 only 18,000 remained in their original locality, and 60,000 out of a total of 90,000 removed Indians had been settled in the Indian Territory.

Now, according to the report of the Indian Commissioner for 1879, the population of the five so-called civilized tribes in that Territory, viz., the Cherokees, Choctaws, Chickasaws, Creeks, and Seminoles, was 60,000; and the remaining reservations in the same Territory, some six or seven in number, include several thousands, so that the civilized tribes must have undergone considerable increase. Colonel Otis estimates that the Cherokee tribe has doubled in the last century.† He

* *Vide* "The Indian Question," by Elwell S. Otis, lieutenant-colonel United States Army, chapter i.

† Ibid., p. 44.

believes that some 10,000 or more of the tribe are elsewhere than in the Indian Territory, making 30,000 in all, and cites an enumeration by the War Department in 1827, preparatory to their removal, showing 13,567 individuals at that time. If we do not accept the view of an increase of one hundred per cent in a hundred years, we must at least concede a gain of fifty per cent in the last fifty years, and it is probable that the increase has occurred mainly in that time. The same authority says the Creeks, Choctaws, and Chickasaws are increasing in numbers. The fifth tribe, the Seminoles, who, after our war with them, in 1842, were reduced to three hundred, now number 2,560.* The "Six Nations," who remained by preference in New York, rather than migrate, are of course under circumstances permitting an accurate census, and their numbers seem to remain constant at about 7,000.

The remainder of the tribes are decreasing in numbers. This can not be doubted. The figures of the Government reports of the aggregate Indian population within the last fifty years are as follows: 1822, 457,000; 1830, 313,000; 1840, 400,000; 1855, 350,000; 1872, 300,000; 1879, 252,897. Even if we were to admit with Colonel Otis that such enumerations are vague and unreliable, and that the aggregate number of Indians remains about the same that it has been for the past two centuries, the increase of the civilized tribes necessarily implies the decrease of the remainder to keep the total unchanged.

The same thing is shown directly by the history of such of the uncivilized tribes as by reason of fortuitous historical associations have been brought under special observation. For instance, the Delaware Indians, made famous by Penn's negotiations with them, were, two hundred and fifty years ago, undoubtedly a large and powerful tribe, occupying much of the present States of Pennsylvania (Central) and New Jersey. In 1763 they had six hundred warriors, and it was even proposed to organize this tribe into a fourteenth State of the American Confederation, in 1778. After the Revolution, they removed to Ohio, then to Missouri, then to Kansas, then to the Cherokee country. Now the remains of the tribe in the Indian Territory number only about a thousand. The history of the Pueblo tribes confirms the same view. In 1540 the Spanish explorers found these people as a large and flourishing kingdom. Even making the great allowance which modern investigation seems to show necessary for the exaggeration of the Spaniards as to the power and wealth of the aborigines, even admitting that there was never any Aztec or Maya empire,† and that what did exist was only a military democracy or league of free tribes, it can not be doubted that the tribes were of great strength and importance. The ruined Pueblos themselves bear witness to this. In fact, it is only twelve years ago (1872) since a census showed these Indians as num-

* Report of the Indian Commissioner, 1879.

† *Vide* T. W. Higginson, in "Harper's Monthly Magazine," August, 1882; also, Lewis H. Morgan, in the "North American Review," April, 1876.

bering 7,683. Yet now the Zuñis, made familiar to all by Mr. Cushing's recent residence among them, are almost the sole survivors of that ancient race, and they number only about sixteen hundred persons. And, what is especially to the purpose of the present discussion, this tribe was of all the most isolated, and the least contaminated by either Spanish or Anglo-American civilization; all the other (river) Pueblos, now practically extinct, having been brought more into contact with the influence of the whites.* What civilization the Zuñis have (if indeed that term can be used at all where there is no written language), the agriculture, the manufacture of pottery and blankets, are wholly historic in origin, this conservative people never having borrowed anything from the Anglo-Saxon or any other race.

From this brief view of the Indian population we must conclude that, so far from its being on the increase as a whole, as some recent writers have claimed, the gain is entirely confined to those few tribes which deserve in a great degree the epithet commonly applied to them, of the "civilized Indians." Taking the Cherokees as representatives of these tribes, we find that they have been under missionary influence for two hundred and fifty years, and that there were eight thousand religious converts among them so long ago as 1700. The traveler Bartram,† writing about 1762, said of them: "They are just, honest, liberal, and hospitable to strangers; considerate, loving, and affectionate to their wives and relations; fond of their children, industrious, frugal, temperate, and persevering, charitable and forbearing." He speaks, moreover, of their wearing woven fabrics, of their police arrangements, their domestic economy, and particularly of their marked loyalty to the dictates of conscience. The Cherokees, then, had fairly entered on the path of progress a hundred and twenty years ago. To-day they possess sufficient property, if equally divided, to give each man, woman, and child, a thousand dollars. Their school expense amounts to thirty-five dollars annually per scholar, a sum greater than that similarly expended, even in our great center of philosophy. The proportion of illiteracy is smaller than that throughout the United States. "Their condition is far better than that of the agricultural classes of England."‡ The five civilized tribes have, on the average, a house for every three or four persons, and one hundred and ninety-five schools and one hundred and thirty-one church edifices for the population of sixty thousand individuals.#

In view, then, of the time spent and the result reached, we may consider that those tribes which are increasing in numbers have passed through their period of acclimation, and we may still believe that the

* *Vide* "The Last of the Pueblos," "Harper's Monthly," June, 1882.

† *Vide* note to the journal of Father Charlevoix, "Historical Collections of Louisiana," vol. iii, p. 130.

‡ "The Indian Question," by Francis A. Walker, p. 57.

\# *Vide* report of the Indian Commissioner for 1879.

law of arrest, exemplified in the early history of the Cherokees, is now in operation in the majority of the Indian tribes, as in all other peoples exposed to the sudden contact of a new culture. A late Commissioner of Indian affairs * says, "Indian blood, thus far in the history of this country, has tended decidedly toward extinction." And the most recent writer on the Indian question tells us that wherever civilization is attempted among those people "the results are at first discouraging, with increased mortality and disease." †

These three races, the Hawaiian, the Maori, and the American, have been selected as the best instances of the adoption of a civilization involving complete and radical changes in mental, moral, and physical circumstances, made with some spontaneity, perhaps, in a few cases, but still essentially alien from the natural tendencies of the people, and devoid of that great safeguard of gradualness which Nature, when left to herself, throws about that critical process. In these peoples the exposure to the new leaven has been most sudden and most complete. We may allude, however, in passing, to some of the less perfect illustrations of the same process. The African negro has been in contact with the whites nearly as long as the Indian, but under circumstances widely different. Up to twenty years ago he was sedulously kept from becoming civilized. It was the express aim of his masters to repress his intellectual nature as completely as possible. The effect of his enslavement, then, was not to civilize him in any sense, but merely to change him from a wild animal into a domesticated or "tame" one. Since the war, his condition as a whole, in the South, has not materially changed in this respect. Of course, now and then an individual has emerged into an intellectual consciousness, and has become an intelligent and civilized member of society. But the great multitude, ignorant, improvident, lazy, have undergone no sufficient change in their natural way of living to disturb their physical equipoise, and with food enough to keep their bodies well nourished, and with scarcely a conscious nervous system, they increase and multiply faster than our white population.‡

Japan is a country which has undergone a most remarkable and sudden mental awakening. But here we are deterred by two facts from tracing any effect upon the stability of the physical organization of the people. In the first place, the intellectual development has not permeated the whole social structure. Only a small class have as yet felt it. In the second place, the movement is so recent, beginning since the revolution of 1868, that sufficient time has not elapsed for it

* General Walker, *loc. cit.*, p. 54.

† "The Red Man and the White Man in America," George E. Ellis, p. 624.

‡ The census returns of the colored population are in round numbers as follows, for the successive decades of this century: 1810, 1,191,000; 1820, 1,538,000; 1830, 2,009,000; 1840, 2,487,000; 1850, 3,254,313; 1860, 3,954,000; 1870, 4,880,000; 1880, 6,581,000.

to show an effect upon the bodily condition even of those whom it has affected.

If, as appears to be the case, a markedly increased mortality attends upon the rapid civilization of a race, to what are we to ascribe it? Obviously, not to the same influences which, in a cultivated nation, we have found to be sources of physical weakness. For in the latter case the factors are such as have acted through several generations; while in the former they are expended most strongly on the generation upon which the sudden change of *régime* has fallen, and which has not yet had time to develop (for instance) a neuropathic tendency. In considering some of the additional and peculiar elements operating in these peoples, we may say, first, that the diminished number and vigor of the population are in some degree a temporary result of the sudden abolition of polygamy. It is true that observation shows clearly that monogamous parents propagate a more vigorous and on the whole a more numerous race than polygamous ones. In the latter case more children are born, but much fewer grow up, and those who do attain years of manhood are less virile than in nations where the unions are single.* An Oriental gentleman remarked to a European traveler that by his various wives he had had sixty children born to him, but that only seven had lived to grow up. This may perhaps be taken as a fair indication of the results of such unions. But, while polygamy is as debasing to the physical as to the moral nature, it is entirely possible that the primary effect of a sudden abolition of multiple marriages may be a reduction in the birth-rate, while the children that are born do not as yet participate in the physical benefits which, after two or three generations, will follow the improved marital relation.

Again, we have to consider the so-called "vices of civilization"—a term which, in itself, involves a contradiction. Properly speaking, the alcohol and opium habits, and other diseases (not to be here mentioned), form no part of civilization. There should be no connection between it and any *vice*. The word, in its true and original meaning, signifies a fault, an abnormality. Surely, the blemish which occurs on any growth is not to be fairly reckoned as a part of that growth. Civilization is not responsible for its so-called vices. Yet the fact is indisputable that these evil habits and passions are, as it were, beasts of prey, skulking along the march of progress, seizing upon those who fail or falter by the way, and indeed finding their victims among all but the best-disciplined and the most steadfast of the host. They do not belong to civilization, but they invariably attend upon it; and the people along the line of progress are, until they become firmly incorporated in the moving column, especially subject to becoming the prey of those hyenas.

The most frequent agent which establishes connection between

* *Vide* "Journal of the Statistical Society," vol. xxviii, p. 271.

civilized and barbarous peoples is trade. Even when the initial move has been made by the missionary, the trader, scenting the chance for gain, is not slow to follow. In this way one of the earliest forces brought to bear upon the barbarian is that of the sailor and the trader. Unfortunately, there is hardly a class of Anglo-European society whose moral influence is so bad as that of the seamen. The trader sends those commodities which will prove most attractive to the barbarian ; and the latter, with his moral nature as yet uneducated, and his power of self-denial undeveloped, is impelled toward the grossest pleasures of intemperance and licentiousness. Even if he only exchange his native indulgences for those brought by the white traders, the effect is most disastrous. The raw American whisky does its deadly work faster than his own "palmy wine."

The policy of the trader finds a response in the attraction of the untutored mind toward the new indulgence ; and, too often, the preaching of the missionary is more than offset by the practices of the money-seeking trader who has come in the same ship with him. Yet this, it should be remembered, is only incidental. Civilization is to the savage what education is to the child, and one of its objects, attainable perhaps not in one or two generations, is to teach him self-restraint. It certainly is not responsible for his failures in that quality.*

The positive influences which are for a time deleterious to a people in process of civilization are probably much more physical than mental. The mind is not sufficiently taxed to create any disturbance in the economy ; and the history of the Indian children who have been brought to the schools at Hampton and Carlisle for education does not show any evil consequences to their health from the intellectual impetus given them, they being selected from tribes where the physical condition, food, clothing, etc., were already approximated to the usages of the whites.

Probably no single influence has had so deleterious an effect upon the physique of the rapidly civilized peoples as *clothing*. Of course, no one will deny Carlyle's doctrine that man is essentially a clothes-wearing animal, and that dress is absolutely necessary in a cultivated community. The climatic conditions of many denizens of the tropics do not require clothing as a matter of protection or comfort, and consequently they do not wear it to any extent. When civilization reaches those people it says, "You must be dressed." Indeed, too often a European or a New England culture says, "You must be dressed in

* We may quote in this connection the words of Morel ("Traité des dégénérescences, physiques, intellectuelles, et morales, de l'espèce humaine," p. 494): "For limited societies, like the indigenous tribes which still exist in America, for other societies even more numerous, that have yet only passed through the period of infancy, which is that of desire, the contact of civilization is a fatal thing—when, instead of the moral law of which it ought to be the harbinger, civilization only brings to them the means of satisfying their grosser appetites as well as the bad tendencies, fruit of the complete lack of instruction, either acquired or inherited."

European or in New England fashion." This is only one phase of a wide-spread and mischievous tendency to impose the particular habits of the new teachers, as being an essential element in race-development, without regard to the natural leanings of the people in question. Many of our customs are purely arbitrary, and it is worse than folly to attempt to impose them upon a new-found race. The civilization of New England is undoubtedly an admirable one, but why insist on making New-Englanders out of Hottentots? Educate them, Christianize them, but do not oblige them to conform to customs which are the accident of another climate and another race. In nothing is this disposition to enforce conformity with an arbitrary standard more injurious and yet more absurd than in the matter of clothes. It would be hard to maintain that the frock-coat or the linen shirt-front of the present representatives of the Anglo-Saxon race are either graceful in the abstract or especially adapted to the use and comfort even of their wearers. Why, then, impose them upon the Sandwich-Islander, or why make them a test of the civilization of the American Indian, by classifying the tribes into the savages and those that wear "citizens' clothes"? We affirm with all seriousness that there is no reason why the inhabitant of the tropics should be expected to wear clothing in form or material like what happens to be in vogue among the dwellers in the temperate zone on the other side of the globe. The grotesque combinations in the habiliments of the Hawaiians, as described by Mark Twain, are as painful to the reason as they are ludicrous to the imagination. Why, for example, need the good missionary women have exerted themselves to make a broadcloth coat for the king of the islands? It and what it represented have been a fruitful source of disease and death to the simple people of that balmy summer clime.

But we may go a step further, and declare that even if a wise liberality allows the savage to dress somewhat in accordance with the requirements of his climate and his pursuits, there yet remains a certain conflict between the minimum demands of civilization in this respect and his bodily welfare, at least until he and his descendants become educated into a tolerance of the new requirement, dress. Consider that we are supposing the case of a dweller in the tropics, where, as a matter of protection, clothing is not required. The temperature is for the most part balmy, and, when it does grow colder, that wonderful mechanism whereby the body is protected from the changes in the surrounding medium does its perfect work. The skin, shiny, tough, and hardy, performs its function well, and "catching cold" is a rare thing. The man, *as an animal*, has no more need of clothing than the beasts around him. But, when he becomes civilized, this must all change. His smooth, dark skin must be covered. Decency and the laws of society require it. It is inevitable, so soon as he begins to be anything more than an animal. What happens? That skin, shut in from the sun and air, loses its quick power of accommodation. Its

natural moisture is not allowed to dry. The man is in an atmosphere, now hot and moist, now cold and moist. His clothing can not adjust itself to the changes of temperature so well as his skin once could. He gets wet in a rain, and is chilled by the drenched clothing which does not dry as his skin would have done. He begins to experience the phenomenon of taking cold. The multiform ailments which thus originate begin to beset him. The lungs especially are apt to suffer, and his health is seriously broken. Once he had a thick skin, the perfect clothing which Nature gives her animals. Now, a thinner, more sensitive one grows under the habiliments that mark the new social order. This is not merely theory. The New-Zealanders themselves ascribe their physical decay in part to their assumption of clothing.* Mr. Nordhoff, in his book on the Sandwich Islands, also alludes to this as one possible cause of the decay of that people. In the case of the African slaves the element of clothing is of less consequence. For here the people have been removed from their native climate to one which necessitates some clothing on grounds of actual comfort. Morover, they were not as a rule obliged to wear more than the real demands of the climate required ; so that there was not even a temporary decrease of their numbers from this cause. But in tropical peoples, and in all others where the innovation in the matter of dress is independent of any real physical requirements, theory and fact agree in ascribing a malign influence to the change. In the ancient myth, Hercules untiringly endured his mighty labors, and was victorious in all his sturdy conflicts with opposing forces ; but, at last, the poisoned robe of Nessus brought him to his death. So to many a child of Nature has the garb of civilization proved an envenomed mantle, consuming its wearer.

Closely connected with the subject of clothing is that of food ; for physiology shows us a reciprocal relation between them. The life of a starving animal can be prolonged by retaining his warmth, or, in other words, by clothing him ; and, conversely, an increase of clothing diminishes the consumption of food. When our newly civilized barbarian puts on clothing which the temperature of his climate does not require, he must lower his diet in a corresponding degree. The extent of this influence may be appreciated from a brief view of the physiology of nutrition. The non-nitrogenous articles of food and the non-nitrogenous modicum which remains after the splitting up of the nitrogenous (proteid) foods furnish the energy of the body. This is estimated in the average man at one million metre-kilogrammes daily ; the force required to raise one kilogramme in weight one metre in height being the unit of force. Now, of this force, 150,000 metre-kilogrammes are expended in muscular work, and the remainder, four fifths or more, are required to maintain the animal heat. But three fourths of the entire heat expenditure is made by radiation and con-

* *Vide* F. D. Fenton, *loc. cit.*, "Journal of the Statistical Society," pp. 524, 529.

duction from the surface of the body.* Of course, the adoption of clothing does not prevent the whole of this radiation of heat. But it does affect most strongly the one strongest factor in the demand for food. It relieves to a considerable extent an expenditure which has required for its maintenance at least three fifths of the whole food-consumption of the body. This sudden and remarkable curtailment in the alimentation of the individual can but produce a profound effect upon the whole nutrient apparatus of the body. Or, if, escaping this danger, the individual does not lessen his diet to correspond to the new scale of requirements, he is exposed to the perils of overfeeding, because he is taking an amount of food which has now become largely in excess of his necessities. Moreover, the risks from quantity of food are enhanced by others from its quality. The new civilization brings new kinds of food. Meat-eating is encouraged as being in accord with the usages of temperate climes, without regard to what the requirements of the tropical animal may be. With the new kinds of food comes new cooking. Rational cooking is not a characteristic of early periods of civilization, or of frontier methods; and irrational cooking—always harmful—is particularly so to those who have never been hardened to it. And so it comes to pass that the frying-pan is added to the dangerous weapons put by civilization into the savage's hand.

Connected with these agencies, but more especially operative among the more northern peoples, as for instance the American Indians, are the influences of ill-ventilated and improperly heated dwellings. Ventilation and domestic sanitation are among the most recent of sciences, and even in the oldest centers of civilization are only just beginning to be given the consideration due to their importance. What wonder, then, that the Indian, accustomed to the airiness of a loosely built wigwam or a hut of boughs, should find, in the closely joined cabin that the white man teaches him to build, a source of foul and poisoned air to which his previous wild life makes him especially sensitive? Between the Scylla of carbonic-acid gas and animal effluvia and the Charybdis of cold draughts the savage steers a troublous course in the early years of his living under his "own roof." And, if, perchance, the trader has sold him an "air-tight stove" as a substitute for his former camp-fire, his perils truly thicken.

Finally, we must not omit to mention the moral and psychical influences which, though not tangible, are nevertheless powerful, and whose effect in the very awakening of a people is not altogether favorable to a calm and healthy life. There is a sudden disturbance of the mental equipoise by the introduction of new wants and new aims. A savage once brought directly into the current of the activities of civilization can never be again just what he was. An undefined but powerful desire and unrest have taken possession of him. When once the note of progress has sounded in a people's ears, its echoes do not easily

* *Vide* Foster's "Physiology," p. 323, *et seq.*

die out. Tecumseh struggled in vain against this impelling force, and pleaded that his people might be suffered to be as they were, but in vain.

The new leaven has been deposited, and its working is inevitable. Men say: "Let the savage alone; do not try to teach him civilization; he is happier in the state of nature than he can be in any that is more artificial"—and perhaps they tell the truth. It is a thorny path—this of progress—and the first step costs the most. We may even admit, with a recent distinguished sympathizer in the retrogressive leanings toward the simplicity of savagedom: "It is the direct tendency of our civilization to carry human beings toward an extreme as far beyond the simple elements of happiness and every form of good as savage life falls short of them." *

Doubtless, development increases the capacity both for enjoyment and for suffering. And if it be questioned whether joy or sorrow predominates in the experiences of our highest civilization, it may well be doubted whether, in the first awakenings of a people, when the power of judging between good and evil has not yet been formed, and when self-control is as yet unknown, the evil influences do not outweigh the good. Left to himself, the child in his early gropings gets many a bruise, many a tumble; yet, once having breathed the breath of life, the infant race is thenceforward impelled by a law inexorable as human destiny. If, as some advise, we abandon these people, and say: "We will not help you along a path which is one of toil and unrest; be as you were," they will not, it is true, progress in any orderly or efficient manner, but *they will not be as they once were.* We can guide them, or we can leave them to the painful and disordered action of their own struggling spirits. They can not return to their former quiet and contented sphere. Restlessness is an essential antecedent to progress; but restlessness implies conflict and labor. It is something higher than purposeless repose; but it is something harder. Of old it was said to the woman, "In sorrow shalt thou bring forth children"; and, by a law as universal, the birth of mind, in nations as well as in individuals, is not without a pang.

RELIGION AND THE DOCTRINE OF EVOLUTION.†

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THE regularity of nature is the first postulate of Science; but it requires the very slightest observation to show us that, along with this regularity, there exists a vast irregularity, which Science can only deal with by exclusion from its province. The world as we see

* Dr. George E. Ellis, *loc. cit.*, p. 597.

† Abstracted from "The Relations between Religion and Science," by the Lord Bishop of Exeter.

it is full of changes; and these changes, when patiently and perseveringly examined, are found to be subject to invariable, or almost invariable, laws. But the things themselves which thus change are as multifarious as the changes which they undergo. They vary infinitely in quantity, in qualities, in arrangement throughout space, possibly in arrangement throughout time. Take a single substance such, say, as gold. How much gold there is in the whole universe, and where it is situated, we not only have no knowledge, but can hardly be said to be on the way to have knowledge. Why its qualities are what they are, and why it alone possesses all these qualities; how long it has existed, and how long it will continue to exist, these questions we are unable to answer. The existence of the many forms of matter, the properties of each form, the distribution of each: all this Science must in the last resort assume.

But I say in the last resort. For it is possible, and Science soon makes it evident that it is true, that some forms of matter grow out of other forms. There are endless combinations. And the growth of new out of old forms is of necessity a sequence, and falls under the law of invariability of sequences, and becomes the subject-matter of science. As in each separate case Science asserts each event of to-day to have followed by a law of invariable sequence on the events of yesterday; the earth has reached the precise point in its orbit now which was determined by the law of gravitation as applied to its motion at the point which it reached a moment ago; the weather of the present hour has come by meteorological laws out of the weather of the last hour; the crops and the flocks now found on the surface of the habitable earth are the necessary outcome of preceding harvests and preceding flocks, and of all that has been done to maintain and increase them; so, too, if we look at the universe as a whole, the present condition of that whole is, if the scientific postulate of invariable sequence be admitted, and in as far as it is admitted, the necessary outcome of its former condition; and all the various forms of matter, whether living or inanimate, must, for the same reason and with the same limitation, be the necessary outcome of preceding forms of matter. This is the foundation of the doctrine of evolution.

Now, stated in this abstract form, this doctrine will be, and indeed if science be admitted at all must be, accepted by everybody. Even the Roman Church, which holds that God is perpetually interfering with the course of nature, either in the interests of religious truth or out of loving-kindness to his creatures, yet will acknowledge that the number of such interferences almost disappears in comparison of the countless millions of instances in which there is no reason to believe in any interference at all. And, if we look at the universe as a whole, the general proposition as stated above is quite unaffected by the infinitesimal exception which is to be made by a believer in frequent miracles. But when this proposition is applied in detail it at once

introduces the possibility of an entirely new history of the material universe. For this universe, as we see it, is almost entirely made up of composite and not of simple substances. We have been able to analyze all the substances that we know into a comparatively small number of simple elements—some usually solid, some liquid, some gaseous. But these simple elements are rarely found uncombined with others; most of those which we meet with in a pure state have been taken out of combination and reduced to simplicity by human agency. The various metals that we ordinarily use are mostly found in a state of ore, and we do not generally obtain them pure except by smelting. The air we breathe, though not a compound, is a mixture. The water which is essential to our life is a compound. And, if we pass from inorganic to organic substances, all vegetables and animals are compound, sustained by various articles of food which go to make up their frames. Now, how have these compounds been formed? It is quite possible that some of them, or all of them to some extent, may have been formed from the first. If Science could go back to the beginning of all things, which it obviously can not, it might find the composition already accomplished, and be compelled to start with it as a given fact—a fact as incapable of scientific explanation as the existence of matter at all. But, on the other hand, composition and decomposition is a matter of every-day experience. Our very food could not nourish us except by passing through these processes in our bodies; and by the same processes we prepare much of our food before consuming it. May not Science go back to the time when these processes had not yet begun? May not the starting-point of the history of the universe be a condition in which the simple elements were still uncombined? If Science could go back to the beginning of all things, might we not find all the elements of material things ready indeed for the action of the inherent forces which would presently unite them in an infinite variety of combinations, but as yet still separate from each other? Scattered through enormous regions of space, but drawn together by the force of gravitation; their original heat, whatever it may have been, increased by their mutual collision; made to act chemically on one another by such increase or by subsequent decrease of temperature; perpetually approaching nearer to the forms into which, by the incessant action of the same forces, the present universe has grown—these elements, and the working of the several laws of their own proper nature, may be enough to account scientifically for all the phenomena that we observe. We do not even then get back to regularity. Why these elements, and no others; why in these precise quantities; why so distributed in space; why endowed with these properties: still are questions which Science can not answer, and there seems no reason to expect that any scientific answer will ever be possible. Nay, I know not whether it may not be asserted that the impossibility of answering one at least among these questions is capable of demonstration. For

the whole system of things, as far as we know it, depends on the perpetual rotation of the heavenly bodies; and without original irregularity in the distribution of matter no motion of rotation could ever have spontaneously arisen. And, if this irregularity be thus original, Science can give no account of it. Science, therefore, will have to begin with assuming certain facts for which it can never hope to account. But it *may* begin by assuming that, speaking roughly, the universe was always very much what we see it now, and that composition and decomposition have always nearly balanced each other, and that there have been from the beginning the same sun and moon and planets and stars in the sky, the same animals on the earth and in the seas, the same vegetation, the same minerals; and that though there have been incessant changes, and possibly all these changes in one general direction, yet these changes have never amounted to what would furnish a scientific explanation of the forms which matter has assumed. Or, on the other hand, Science *may* assert the possibility of going back to a far earlier condition of our material system; may assert that all the forms of matter have grown up under the action of laws and forces still at work; may take as the initial state of our universe one or many enormous clouds of gaseous matter, and endeavor to trace with more or less exactness how these gradually formed themselves into what we see. Science has lately leaned to the latter alternative. To a believer the alternative may be stated thus: We all distinguish between the original creation of the material world and the history of it ever since. And we have, nay all men have, been accustomed to assign to the original creation a great deal that Science is now disposed to assign to the history. But the distinction between the original creation and the subsequent history would still remain, and forever remain, although the portion assigned to the one may be less, and that assigned to the other larger, than was formerly supposed. However far back Science may be able to push its beginning, there still must lie behind that beginning the original act of creation—creation not of matter only, but of the various kinds of matter, and of the laws governing all and each of those kinds, and of the distribution of this matter in space.

This application of the abstract doctrine of evolution gives it an enormous and startling expansion—so enormous and so startling that the doctrine itself seems absolutely new. To say that the present grows by regular law out of the past is one thing; to say that it has grown out of a distant past in which as yet the present forms of life upon the earth, the present vegetation, the seas and islands and continents, the very planet itself, the sun and moon, were not yet made—and all this also by regular law—that is quite another thing. And the bearings of this new application of science deserve study.

Now, it seems quite plain that this doctrine of evolution is in no sense whatever antagonistic to the teachings of religion, though it may

be, and that we shall have to consider afterward, to the teachings of revelation. Why, then, should religious men, independently of its relation to revelation, shrink from it, as very many unquestionably do? The reason is that, while this doctrine leaves the truth of the existence and supremacy of God exactly where it was, it cuts away, or appears to cut away, some of the main arguments for that truth.

Now, in regard to the arguments whereby we have been accustomed to prove or to corroborate the existence of a Supreme Being, it is plain that, to take these arguments away, or to make it impossible to use them, is not to disprove or take away the truth itself. We find every day instances of men resting their faith in a truth on some grounds which we know to be untenable, and we see what a terrible trial it sometimes is when they find out that this is so, and know not as yet on what other ground they are to take their stand. And some men succumb in the trial, and lose their faith, together with the argument which has hitherto supported it. But the truth still stands, in spite of the failure of some to keep their belief in it, and in spite of the impossibility of supporting it by the old arguments.

And, when men have become accustomed to rest their belief on new grounds, the loss of the old arguments is never found to be a very serious matter. Belief in revelation has been shaken again and again by this very increase of knowledge. It was unquestionably a dreadful blow to many in the days of Galileo to find that the language of the Bible in regard to the movement of the earth and sun was not scientifically correct. It was a dreadful blow to many in the days of the Reformation to find that they had been misled by what they believed to be an infallible Church.

Such shocks to faith try the mettle of men's moral and spiritual convictions, and they often refuse altogether to hold what they can no longer establish by the arguments which have hitherto been to them the decisive, perhaps the sole decisive, proofs.

And yet, in spite of these shocks, belief in revelation is strong still in men's souls, and is clearly not yet going to quit the world.

But let us go on to consider how far it is true that the arguments which have hitherto been regarded as proving the existence of a Supreme Creator are really affected very gravely by this doctrine of evolution.

The main argument, which at first appears to be thus set aside, is that which is founded on the marks of design, and which is worked out in his own way with marvelous skill by Paley in his "Natural Theology." Paley's argument rests, as is well known, on the evidence of design in created things, and these evidences he chiefly finds in the framework of organized living creatures. He traces with much most interesting detail the many marvelous contrivances by which animals of various kinds are adapted to the circumstances in which they are to live, the mechanism which enables them to obtain their food, to

preserve their species, to escape their enemies, to remove discomforts. All nature, thus examined, and particularly all animated nature, seems full of means toward ends, and those ends invariably such as a beneficent Creator might well be supposed to have in view. And while there is undeniably one great objection to his whole argument, namely, that the Creator is represented as an artificer rather than a Creator, as overcoming difficulties which stood in his way rather than as an Almighty Being fashioning things according to his will, yet the argument thus drawn from evidence of design remains exceedingly powerful, and it has always been considered a strong corroboration of the voice within which bids us believe in a God. Now, it certainly seems at first as if this argument were altogether destroyed. If animals were not made as we see them, but evolved by natural law, still more if it appear that their wonderful adaptation to their surroundings is due to the influence of those surroundings, it might seem as if we could no longer speak of design as exhibited in their various organs ; the organs, we might say, grow of themselves, some suitable and some unsuitable to the life of the creatures to which they belonged, and the unsuitable have perished and the suitable have survived.

But Paley has supplied the clew to the answer. In his well-known illustration of the watch picked up on the heath by the passing traveler, he points out that the evidence of design is certainly not lessened if it be found that the watch was so constructed that, in course of time, it produced another watch like itself. He was thinking not of evolution, but of the ordinary production of each generation of animals from the preceding. But his answer can be pushed a step further, and we may with equal justice remark that we should certainly not believe it a proof that the watch had come into existence without design if we found that it produced in course of time not merely another watch but a better. It would become more marvelous than ever if we found provision thus made, not merely for the continuance of the species, but for the perpetual improvement of the species. It is essential to animal life that the animal should be adapted to its circumstances ; if, besides provision for such adaptation in each generation, we find provision for still better adaptation in future generations, how can it be said that the evidences of design are diminished ? Or take any separate organ, such as the eye. It is impossible not to believe, until it be disproved, that the eye was intended to see with. We can not say that light was made for the eye, because light subserves many other purposes besides that of enabling eyes to see. But that the eye was intended for light there is so strong a presumption that it can not easily be rebutted. If, indeed, it could be shown that eyes fulfilled several other functions, or that species of animals which always lived in the dark still had fully-formed eyes, then we might say that the connection between the eye of an animal and the light of heaven was accidental. But the contrary is notoriously the case—so much the case

that some philosophers have maintained that the eye was formed by the need for seeing, a statement which I need take no trouble to refute, just as those who make it take no trouble to establish, I will not say truth, but even its possibility. But the fact, if it be a fact, that the eye was not originally as well adapted to see with as it it is now, and that the power of perceiving light and of things in the light grew by degrees, does not show, nor even tend to show, that the eye was not intended for seeing with.

The fact is that the doctrine of evolution does not affect the substance of Paley's argument at all. The marks of design which he has pointed out remain marks of design still even if we accept the doctrine of evolution to the full. What is touched by this doctrine is not the evidence of design but the mode in which the design was executed. Paley, no doubt, wrote on the supposition (and at that time it was hardly possible to admit any other supposition) that we must take animals to have come into existence very nearly such as we now know them: and his language, on the whole, was adapted to that supposition. But the language would rather need supplementing than changing to make it applicable to the supposition that animals were formed by evolution. In the one case the execution follows the design by the effect of a direct act of creation ; in the other case the design is worked out by a slow process. In the one case the Creator made the animals at once such as they now are ; in the other case he impressed on certain particles of matter, which, either at the beginning or at some point in the history of his creation, he endowed with life, such inherent powers that in the ordinary course of time living creatures such as the present were developed. The creative power remains the same in either case ; the design with which that creative power was exercised remains the same. He did not make the things, we may say ; no, but he made them make themselves. And surely this rather adds than withdraws force from the great argument. It seems in itself something more majestic, something more befitting him to whom a thousand years are as one day and one day as a thousand years, thus to impress his will once for all on his creation, and provide for all its countless variety by this one original impress, than by special acts of creation to be perpetually modifying what he had previously made. It has often been objected to Paley's argument, as I remarked before, that it represents the Almighty rather as an artificer than a creator, a workman dealing with somewhat intractable materials and showing marvelous skill in overcoming difficulties rather than a beneficent Being making all things in accordance with the purposes of his love. But this objection disappears when we put the argument into the shape which the doctrine of evolution demands, and look on the Almighty as creating the original elements of matter, determining their number and their properties, creating the law of gravitation whereby as seems probable the worlds have been formed, creating the various laws of chemical and physical

action, by which inorganic substances have been combined, creating above all the law of life, the mysterious law which plainly contains such wonderful possibilities within itself, and thus providing for the ultimate development of all the many wonders of nature.

What conception of foresight and purpose can rise above that which imagines all history gathered as it were into one original creative act from which the infinite variety of the universe has come and more is coming even yet?

And yet again, it is a common objection to Paley's and similar arguments that, in spite of all the tokens of intelligence and beneficence in the creation, there is so much of the contrary character. How much there is of apparently needless pain and waste! And John Stuart Mill has urged that either we must suppose the Creator wanting in omnipotence or wanting in kindness to have left his creation so imperfect. The answer usually given is that our knowledge is partial, and, could we see the whole, the objection would probably disappear. But what force and clearness are given to this answer by the doctrine of evolution, which tells us that we are looking at a work which is not yet finished, and that the imperfections are a necessary part of a large design the general outlines of which we may already trace, but the ultimate issue of which, with all its details, is still beyond our perception! The imperfections are like the imperfections of a half-completed picture not yet ready to be seen; they are like the bud which will presently be a beautiful flower, or the larva of a beautiful and gorgeous insect; they are like the imperfections in the moral character of a saint who nevertheless is changing from glory to glory.

To the many partial designs which Paley's "Natural Theology" points out, and which still remain what they were, the doctrine of evolution adds the design of a perpetual progress. Things are so arranged that animals are perpetually better adapted to the life they have to live. The very phrase which we commonly use to sum up Darwin's teaching, the survival of the fittest, implies a perpetual diminution of pain and increase of enjoyment for all creatures that can feel. If they are fitter for their surroundings, most certainly they will find life easier to live. And, as if to mark still more plainly the beneficence of the whole work, the less developed creatures, as we have every reason to believe, are less sensible of pain and pleasure; so that enjoyment appears to grow with the capacity for enjoyment, and suffering diminishes as sensitivity to suffering increases. And there can be no doubt that this is in many ways the tendency of nature. Beasts of prey are diminishing; life is easier for man and easier for all animals that are under his care: many species of animals perish as man fills and subjugates the globe, but those that remain have far greater happiness in their lives. In fact, all the purposes which Paley traces in the formation of living creatures are not only fulfilled by what the Creator has done, but are better fulfilled

from age to age. And, though the progress may be exceedingly slow, the nature of the progress can not be mistaken.

If the "Natural Theology" were now to be written, the stress of the argument would be put on a different place. Instead of insisting wholly or mainly on the wonderful adaptation of means to ends in the structure of living animals and plants, we should look rather to the original properties impressed on matter from the beginning, and on the beneficent consequences that have flowed from those properties. We should dwell on the peculiar properties that must be inherent in the molecules of the original elements to cause such results to follow from their action and reaction on one another. We should dwell on the part played in the universe by the properties of oxygen, the great purifier, and one of the great heat-givers; of carbon, the chief light-giver and heat-giver; of water, the great solvent and the store-house of heat; of the atmosphere and the vapors in it, the protector of the earth which it surrounds. We should trace the beneficent effects of pain and pleasure in their subservience to the purification of life. The marks of a purpose impressed from the first on all creation would be even more visible than ever before.

And we could not overlook the beauty of nature and of all created things as part of that purpose, coming in many cases out of that very survival of the fittest of which Darwin has spoken, and yet a distinct object in itself. For this beauty there is no need in the economy of Nature whatever. The beauty of the starry heavens, which so impressed the mind of Kant that he put it by the side of the moral law as proving the existence of a Creator, is not wanted either for the evolution of the world or for the preservation of living creatures. Our enjoyment of it is a superadded gift certainly not necessary for the existence or the continuance of our species. The beauty of flowers, according to the teaching of the doctrine of evolution, has generally grown out of the need which makes it good for plants to attract insects. The insects carry the pollen from flower to flower, and thus, as it were, mix the breed; and this produces the stronger plants which outlive the competition of the rest. The plants, therefore, which are most conspicuous gain an advantage by attracting insects most. That successive generations of flowers should thus show brighter and brighter colors is intelligible. But the beauty of flowers is far more than mere conspicuousness of colors, even though that be the main ingredient. Why should the wonderful grace, and delicacy, and harmony of tint be added? Is all this mere chance? Is all this superfluity pervading the whole world and perpetually supplying to the highest of living creatures, and that, too, in a real proportion to his superiority, the most refined and elevating of pleasures, an accident without any purpose at all? If evolution has produced the world such as we see and all its endless beauty, it has bestowed on our own dwelling-place in lavish abundance and in marvelous perfection that on which men

spend their substance without stint, that which they value above all but downright necessities, that which they admire beyond all except the law of duty itself. We can not think that this is not designed, nor that the Artist who produced it was blind to what was coming out of his work.

Once more, the doctrine of evolution restores to the science of nature the unity which we should expect in the creation of God. Paley's argument proved design, but included the possibility of many designers. Not one design, but many separate designs, all no doubt of the same character, but all worked out independently of one another, is the picture that he puts before us. But the doctrine of evolution binds all existing things on earth into one. Every mineral, every plant, every animal has such properties that it benefits other things besides itself, and derives benefit in turn. The insect develops the plant, and the plant the insect; the brute aids in the evolution of the man, and the man in that of the brute. All things are embraced in one great design, beginning with the very creation. He who uses the doctrine of evolution to prove that no intelligence planned the world, is undertaking the self-contradictory task of showing that a great machine has no purpose by tracing in detail the marvelous complexity of its parts, and the still more marvelous precision with which all work together to produce a common result.

To conclude, the doctrine of evolution leaves the argument for an intelligent Creator and Governor of the world stronger than it was before. There is still as much as ever the proof of an intelligent purpose pervading all creation. The difference is, that the execution of that purpose belongs more to the original act of creation, less to acts of government since. There is more divine foresight, there is less divine interposition; and whatever has been taken from the latter has been added to the former.

Some scientific students of nature may fancy they can deduce in the working out of the theory results inconsistent with religious belief; and in a future lecture these will have to be examined; and it is possible that the theory may be so presented as to be inconsistent with the teaching of revelation. But, whatever may be the relation of the doctrine of evolution to revelation, it can not be said that this doctrine is antagonistic to religion in its essence. The progress of science in this direction will assuredly end in helping men to believe with more assurance than ever that the Lord by wisdom hath founded the earth, by understanding hath he established the heavens.

LIQUEFACTION OF THE ELEMENTARY GASES.

By JULES JAMIN, of the Institute of France.

THE earlier experiments of MM. Cailletet and Raoul Pictet in the liquefaction of gases, and the apparatus by means of which they performed the process, were described in "The Popular Science Monthly," March and May, 1878. The experiments have since been continued and improved upon by MM. Cailletet and Pictet, and others, with more complete results than had been attained at the time the first reports were published, and with the elucidation of some novel properties of gases, and the disclosure of relations, previously not well understood, between the gaseous and the liquid condition. The experiments of Faraday, in the compression of gases by the combined agency of pressure and extreme cold, left six gases, which still refused to enter into the liquid state. They were the two elements of the atmosphere (oxygen and nitrogen), nitric oxide, marsh-gas, carbonic oxide, and hydrogen. Many new experiments were tried before the principle that governs the change from the gaseous to the liquid, or from the liquid to the gaseous form, was discovered. Aimé sank manometers filled with air into the sea till the pressure upon them was equal to that of four hundred atmospheres ; Berthelot, by the expansion of mercury in a thermometer-tube, succeeded in exerting a pressure of seven hundred and eighty atmospheres upon oxygen. Both series of experiments were without result. M. Cailletet, having fruitlessly subjected air and hydrogen to a pressure of one thousand atmospheres, came to the conclusion that it was impossible to liquefy those gases at the ordinary temperature by pressure alone. Previously it had been thought that the obstacle to condensing gases by pressure alone lay in the difficulty of obtaining sufficient pressure, or in that of finding a vessel suitable for manipulation that would be capable of resisting it. M. Cailletet's thought led to the discovery of another fundamental property of gases.

The experiments of Despretz and Regnault had shown that the scope of Mariotte's law (that the volume of gases increases or diminishes inversely as the pressure upon them) was limited, and that its limits were different with different substances. Andrews confirmed the observations of these investigators, and extended them. Compressing carbonic acid at 13° C. (55° Fahr.), he found that the rate of diminution in volume increased more rapidly than Mariotte's law demanded, and at a progressive rate. At fifty atmospheres the gas all at once assumed the liquid form, became very dense, and fell to the bottom of the vessel, where it remained separated from its vapor by a clearly defined surface, like that which distinguishes water in the air. Experimenting in the same way with the gas at a higher tem-

perature (21° C., or 70° Fahr.), he found that the same result was produced, but more slowly; and it seemed to be heralded in advance by a more rapid diminution in volume previous to the beginning of the change, which continued after the process had been accomplished; as if an anticipatory preparation for the liquid state were going on previous to the completion of the change. Performing the experiment again at 32° C. (90° Fahr.), the anticipatory preparation and the after-continuation of the contraction were more marked, and, instead of a separate and distinct liquid, wavy and mobile striæ were perceived on the sides of the vessel as the only signs of a change of state which had not yet been effected. At temperatures above 32° C. (90° Fahr.), there were neither striæ nor liquefaction, but there seemed to be a suggestion of them, for, under a particular degree of pressure, the density of the gas was augmented, and its volume diminished at an increasing rate. The temperature of 32° C. (90° Fahr.) is, then, a limit, marking a division between the temperatures which permit and those which prevent liquefaction; it is the *critical point*, at which is defined the separation, for carbonic acid, between two very distinct states of matter. Below this point, the particular matter may assume the aspect of a liquid; above it, the gas can not change its appearance, but enters into the opposite constitution from that of a liquid.

Generally, a liquid has considerably greater density than its vapor. But, if a vessel containing both is heated, the liquid experiences a dilatation which is gradually augmented till it equals and even exceeds that of the gas; whence, of course, an equal volume of the liquid will weigh less and less. On the other hand, a constantly larger quantity of vapor is formed, which accumulates above the liquid and becomes heavier and heavier. Now, if the density of the vapor increases, and that of the liquid diminishes, they will reach a point, under a suitable temperature, when they will be the same. There will then be no reason for the liquid to sink or the vapor to rise, or for the existence of any line of separation between them, and they will be mixed and confounded. They will no longer be distinguishable by their heat of constitution. It is true that, in passing into the state of a vapor, a liquid absorbs a great deal of latent heat, but that is employed in scattering the molecules and keeping them at a distance; and there will be none of it if the distance does not increase. We are then, at this stage of our experiments, in the presence of a critical point, at which we do not know whether the matter is liquid or gaseous; for, in either condition, it has the same density, the same heat of constitution, and the same properties. It is a new state, the *gaso-liquid* state. An experiment of Cagniard-Latour re-enforced this explanation of the phenomena. Heating ether in closed vessels to high temperatures, he brought it to a point where the liquid could be made wholly to disappear, or to be suddenly reformed on the slightest elevation or the slightest depression of temperature, accordingly as it was raised just above or cooled

to just below the critical point. The discovery of these properties suggested an explanation of the failure of previous attempts to liquefy air. Air at ordinary low temperatures is in the gaso-liquid condition, and its liquefaction is not possible except when a difference exists between the density of the vapor and that of the liquid greater than it is possible to produce under any conditions than can exist then. It was necessary to reduce the temperature to below the critical point; and it was by adopting this course that MM. Cailletet and Raoul Pictet achieved their success. The rapid escape of the compressed gas itself from a condition of great condensation at an extremely low temperature was employed as the agent for producing a greater degree of cold than it had been possible before to obtain. M. Cailletet used oxygen escaping at —29° C. from a pressure of three hundred atmospheres; M. Raoul Pictet, the same gas escaping at —140° from a pressure of three hundred and twenty atmospheres; and both obtained oxygen and nitrogen, and M. Pictet hydrogen in what they thought was a liquid, and possibly even in a solid form.

Still, it could not be asserted that hydrogen and the elements of the air had been completely liquefied. These gases had not yet been seen collected in the static condition at the bottom of a tube and separated from their vapors by the clearly defined concave surface, which is called a *meniscus*. The experiments had, however, proved that liquefaction is possible at a temperature of below —120° C. (—184° Fahr.). To make the process practicable, it was only necessary to find sufficiently powerful refrigerants; and these were looked for among gases that had proved more refractory than carbonic acid and protoxide of nitrogen. M. Cailletet selected ethylene, a hydrocarbon of the same composition as illuminating gas, which, when liquefied by the aid of carbonic acid and a pressure of thirty-six atmospheres, boils at —103° C. (—153° Fahr.). M. Wroblewski, of Cracow, who had witnessed some of M. Cailletet's experiments, and obtained his apparatus, and M. Olzewski, in association with him, also experimented with ethylene, and had the pleasure of recording their first complete success early in April, 1883. Causing liquid ethylene to boil in an air-pump vacuum at —103° C., they were able to produce a temperature of —150° C. (—238° Fahr.), the lowest that had ever been observed. Oxygen, having been previously compressed in a glass tube, became a permanent liquid, with a clearly defined meniscus. It presented itself, like the other liquefied gases, under the form of a transparent and colorless substance, resembling water, but a little less dense. Its critical point was marked at —113° C. (—171° Fahr.), below which the liquid could be formed, but never above it; while it boiled rapidly at —186° C. (—303° Fahr.). A few days afterward, the Polish professors obtained the liquefaction of nitrogen, a more refractory gas, under a pressure of thirty-six atmospheres, at —146° C. (—231° Fahr.). Long, difficult, and expensive operations were re-

quired to produce this result, for the extreme degree of cold it demanded had to be produced by boiling large quantities of ethylene in a vacuum. M. Cailletet devised a cheaper process, by employing another hydrocarbon that rises from the mud of marshes, and is called *formene*. It is less easily liquefied than ethylene, but for that very reason can be boiled in the air at a lower temperature, or at —160° C. (—256° Fahr.) ; and at this temperature nitrogen and oxygen can be liquefied in a bath of formene as readily as sulphurous acid in the common freezing mixture.

MM. Cailletet, Wroblewski, and Olzewski have continued their experiments in liquefaction and acquired increased facility in the handling of liquid ethylene, formene, atmospheric air, oxygen, and nitrogen. M. Olzewski was able to report to the French Academy of Sciences, on the 21st of July, 1884, that by placing liquefied nitrogen in a vacuum he had succeeded in producing a temperature of —213° C. (—351° Fahr.), under which hydrogen was liquefied. Contrary to the suppositions founded on the metallic behavior of this element, that it would present the appearance of a molten metal, like mercury, the liquid had the mobile behavior and the transparency of the hydrocarbons.

THE OIL-SUPPLY OF THE WORLD.*

II.

MANY and varied are the uses to which human ingenuity has already contrived to turn this precious gift of dirty-green earth-oil. At first its value was only recognized as a lubricating oil for machinery, and a somewhat dangerous burning-oil for illuminating, commonly called kerosene. Now it has been discovered that, by careful refining, all the highly inflammable naphtha, which is the dangerous ingredient, can be separated, and made valuable to painters and chemists, while the oil, thus purified, becomes absolutely safe for domestic use. Another valuable product of petroleum is gasolene—a form of gas most convenient for use in country houses. Then comes precious paraffine, in the form of beautiful wax-light candles, and vaseline, for healing broken skin or bruises. For medical use we have an anæsthetic called rhigolene, and for cleansing we have benzine. Various volatile ethers have been obtained, among others a petroleum-spirit, which acts as a substitute for turpentine, and which will dissolve lacquer. And, after all these good things have been separated, there still remains a residuum of tar, which yields anthracene, benzole, and naphthaline, from which are obtained a madder-red, mauve, magenta, and indigo-blue dyes, which bid fair to supersede those already known to commerce,

* Abridged from "Blackwood's Magazine."

and even seriously to affect the interests of our indigo-planters, as they have already injured the madder-cultivators of Turkey and Holland.

America has devised various furnaces, of which petroleum is the only fuel. These are chiefly used by metal-workers, as it is found that in such labor as bending armor-plates, and iron-work generally, mineral oil raises the required heat in half the time required by iron.

From America we turn to Asia, which, in more senses than one, may be called the Cradle of Light ; for there is good reason to believe that, upward of four thousand years ago, the people of Nineveh and Babylon had found out this use for the mineral oil which flowed from the fountains of Is, on the Euphrates. It was collected in great pits, and the more solid deposits formed the asphalt (or, in Biblical phrase, "slime") which was used by the builders of Babylon to cement their sun-dried bricks.

Whether the petroleum-springs and asphalt-shores of the Dead Sea—the Lake Asphaltites—were ever turned to equally practical purpose does not appear ; but Burmah has long recognized the value of her home supplies of earth-oil, derived from wells near the river Irrawaddy ; and Burmese naphtha and Rangoon tar find their way even to British markets. These Burmese wells are sunk to a depth of about sixty feet, and yield an oil of the consistency of treacle.

I am told that Hindostan and Siberia have alike received their share in this distribution of the earth-mother's gifts, and that both in China and Japan native naphtha has long been employed in certain districts for burning in lamps. I infer, however, that the production can not be very great, as the consumption of American kerosene in those countries is already enormous, and it has found its way to small villages in remote districts of Japan, to which no less than 5,600 tons were last year imported from America. China generally welcomes such foreign boons less readily ; but even the Celestial Empire does not disdain to accept cheap oil, and 82,000 tons were there disposed of last year, while India consumed 94,000 tons.

The Guebres of Persia have ever recognized a sacred fire-symbol in the flame of the native naphtha which flows from the soil in various parts of Persia in so pure a form as to burn without rectification—in fact, the name, though now applied to various artificially produced fluids, is derived from the Persian word *nafata*, "to exude." In its purest natural form it is a light, colorless fluid, consisting of carbon and hydrogen, without any oxygen. In Persia, fire-temples were erected near the naphtha-springs, and reverent pilgrims came from afar to worship at the temple of Surukhani, on the western shore of the Caspian, where, for at least two thousand years, the sacred earth-fed flame burned unceasingly.

In the American consul's report for 1880, he mentioned that this temple was still frequented, that priests came from India to conduct the services, and that inexhaustible supplies of gas to feed the sacred

flame were obtained by merely inserting pipes into the earth. A later report, however, states that since this spot has become so important a center of busy trade and the springs have been desecrated by the imprisonment of the oil and gas in vulgar commercial tanks and pipes, the ancient fire-temple has been abandoned, and in place of reverent worshipers, wondering travelers go for an evening row on the Caspian, to visit the submarine oil-springs to the south of the town of Baku, whence petroleum and naphtha rise to the surface, forming little eddies on the shallow waters (the depth of the sea at this point being only about fourteen feet). On to each eddy they throw a handful of blazing straw, to ignite the naphtha; and thus, on a still, calm night, the sea itself appears to be in flames at a dozen spots—a truly fairy-like illumination.

Besides these submarine springs, the naphtha which exudes from the ground on every side of the old Persian seaport town of Baku is so exceedingly inflammable that the light naphtha-gas was often known to ignite spontaneously, and play in pale lurid flames above fissures in the rock. On stormy nights, fanned by the wind, these flames blazed up, and this led to the town being considered by the Guebres a place of great sanctity. Arabian chroniclers likewise tell of a great volcanic mountain, now extinct, but which, eight centuries ago, was in full action, and doubtless contributed to inspire the fire-worshipers with reverence for the neighborhood.

Great, however, is the change that has come over the sleepy Persian town, with its limited trade in silk and opium, salt, naphtha, and perfumes, since the genius of commerce here established itself, and commenced working so thoroughly in earnest that Baku, which ten years ago was the peaceful home of some 12,000 persons, has now developed into a great commercial center, and a place of daily increasing political importance. It already numbers 30,000 inhabitants, and has very large shipping interests. And this transformation is wholly and solely due to petroleum.

The town which has acquired a new celebrity with such strange rapidity is situated on the Apsheron Peninsula, which is a high, sandy plain, about fifteen miles in width, and projecting thirty miles into the Caspian, from the point where the Caucasus (the mighty boundary which divides European Russia from Asia, Circassia from Georgia) terminates on its shores. It certainly can not be described as an inviting place of residence, for the dry and desert sand is only varied by patches of clay, through which here and there crops up a blue gray-stone.

On every side the ground is black with waste petroleum; indeed, the whole surface of the soil is as a sodden crust, into which, in hot sunshine, the foot sinks to a depth of two or three inches, while in cold weather it hardens to the consistency of asphalt. Every breath of wind raises blinding clouds of parched sand; and water is so scarce

that the streets are watered with coarse, black naphtha, which lays the dust effectually for about a fortnight, and then forms a thick, brown bituminous dust, that ingrains clothes indelibly, but over which carriages glide noiselessly, so that the inhabitants are at least spared one item of torture. On the other hand, they have to breathe an atmosphere poisoned by the dense smoke pouring from the chimneys of about two hundred and fifty refining-factories, and the whole air is redolent of all-pervading petroleum.

Equally desolate and dreary is the surrounding country, which by nature is totally unproductive. Some morsels are carefully cultivated, but there is no natural vegetation, nothing but great dismal flats saturated with the naphtha, which lies on the surface in pools and lakes.

The principal oil-wells of the Baku district lie at Balaxame or Balakhani, about six miles to the northeast of the town: this is an oil-field about three and a half miles in length by one and a half in breadth. To the south lies a smaller field called Bĕbeabat. One fountain at Balakhani, ninety-eight feet in depth, is noted as having been flowing steadily for upward of two years, and still continuing to yield 800 barrels a day. Another well not far off, 490 feet deep, commenced its career by throwing up a jet thirty feet in the air, and then flooding the land with oil for a considerable distance all around, overflowing other wells and several small refineries, so as effectually to stop their work. The roar of the rushing oil and gas could be heard a mile from the spot.

Various flowing wells are said to yield 6,000 barrels a day, and some far more; but, from the fact that these quantities are generally stated in the Russian measure of poods, it is not very easy to realize what is meant. One pood, we learn, is equal to thirty-six pounds English. Hence one thousand poods represent somewhere about sixteen tons. Accounts have just reached England of an oil-fountain which was struck last December, and flows at the rate of from fifty to sixty thousand poods daily, gushing forth with such force as to break in pieces a three-inch cast-iron plate which had been fastened over the well in order to divert the flow in a particular direction. In the same district a huge heap of sand marks the spot where an oil-spring, on being tapped, straightway threw up a column of petroleum to twice the height and size of the Great Geyser in Iceland, forming a huge black fountain two hundred feet in height—a fountain, however, due solely to the removal of the pressure on the confined gas, for there is no trace of volcanic heat. The fountain was visible for many miles round, and on the first day it poured forth abont two million gallons, equal to fifty thousand barrels.

An enterprising photographer who was on the spot secured a photograph which places this matter beyond cavil. The fountain continued to play for five months, gradually decreasing week by week, till it finally ceased to play, leaving its unfortunate owners (an Armenian

company) well-nigh ruined by the claims brought against them by neighbors whose lands were destroyed by the flood of oil.

Until about nine years ago the working of the oil was entirely in the hands of Russians and Armenians, and everything was done in the most slovenly fashion. The oil drawn from the wells was collected in shallow pits, whence it was ladled into barrels or skins, and then transported eight or ten miles on quaint native carts to the refineries at the town. The purified oil was afterward rebarreled, sent by steamer to the mouth of the Volga, transferred to river-boats, and then again transferred to carts, to be thus conveyed to the railway, and so transported to all parts of Russia. But the labor this involved was great, and the expense of carriage was consequently exorbitant. And all this was greatly in favor of America, which could still contrive to pay freight from Pennsylvania, and yet undersell the Baku oil-merchants in their own Russian markets.

The beginning of a new commercial and political era (of which we as yet see only the dawn) dates from the year 1875, when Ludwig Nöbel (one of two Swedish brothers, engineers, whose father had settled in St. Petersburg as a gunsmith) sent his brother Robert to the Caucasus to purchase walnut-wood suitable for making gun-stocks. On his journey Robert Nöbel chanced to visit Baku, and was so struck with the wonderful capabilities of the oil-region that, on relating his impression to Ludwig, the latter sent him back to make further investigations, and soon afterward followed in person, when he found that the reality far exceeded all that he had heard.

At once perceiving the enormous advantages to be derived from systematic working, with the aid of iron cisterns and pipes, the brothers sought to interest others in the matter, and induce them to co-operate with them. This, however, they found to be quite in vain. Their theories were all denounced as utter folly. The oil-producers, the land transport corps of carriers, the steamboat and railway companies, all refused to aid their schemes, so there was nothing for it but to start unaided in their own fashion.

They calculated that to do so would involve an outlay of about £1,380,000, and to obtain the needful capital it was necessary to fire others with something of their own enthusiasm. The energetic Swedes were not to be daunted. Difficulties of every sort were thrown in their way, but one by one each was fought and conquered. First they imported a body of wise and steady Swedes whom they could trust to work faithfully for them. They then established great refineries at Baku, laid down oil-pipes thence to the oil-fields of Balakhani (distant upward of six miles), and there commenced scientific boring to a depth greater than had yet been attempted. When their borers struck oil there was no waste, as at the other wells, for the pipes were ready to carry the oil direct to the refineries.

The first step having thus been taken, the next was to avoid the

great cost of barrels (and here we must note that the total absence of timber from all this region is a very serious item in working expenses, as all the wood required for the derricks and other erections must be imported from afar).

In order to dispense with barrels, the Nöbel brothers resolved to carry pipes from their refineries to the sea-coast, so as to pump the oil direct into great iron tanks on board the steamers, whence it might at the end of its voyage be pumped into tanks on the railway, and so carried to great reservoirs in all parts of Russia. As the railway and steamboat companies persisted in their refusal to co-operate, the Nöbels were compelled to take every department of their business entirely into their own hands. So they sent to Stockholm and to Russia to have steamers built specially for their own trade, fitted with great cisterns capable of containing seven hundred and fifty tons of oil, and constructed to burn only oil-fuel. They now own upward of a dozen large steamers on the Caspian, and thirty specially adapted for traffic on the Volga; and, besides these, they charter fully twoscore more steamers to carry their naphtha refuse to various ports for sale.

The petroleum shipped at Baku is carried direct to Tzaritzin on the Volga, whence it is dispatched by rail to every part of the empire in trains, each numbering twenty-five oil-cars. Thus it is conveyed even to the shores of the Baltic, whence it passes on to Sweden, to Germany, and wherever else it can effect an entrance, in determined rivalry to the petroleum of America, which it has already well-nigh expelled from the vast Russian market.

In every direction is the Caspian oil now spreading. In 1883 about a thousand tons were sent to England to try the British market. A somewhat larger quantity was sold in France, and extensive orders were taken for Austria. But it must have required the inventive genius of a Swede to think of sending coals to Newcastle, in the form of sending lubricating oil for machinery to America, and even this has been successfully done! And now that the railway has been completed from Baku to Tiflis, and to Poti and Batoum on the Black Sea, the market of the whole world is open to receive the inexhaustible supplies of the Caucasian oil-fields. Turkey, and all lands on the shores of the Mediterranean, with all that may be reached *via* the Suez Canal and Red Sea, Southern India, China, and Japan—all are open markets for whoever can supply the best oil at the cheapest rate. It is therefore evident that America has now a formidable rival in the field.

Of the relative merits of Pennsylvanian and Caspian oil, it may be said generally that the former yields on an average seventy per cent of kerosene, with a large residuum of lubricating oil. The latter yields only from twenty-five to thirty-five per cent of pure oil, and from twenty to thirty per cent is refuse, only fit for fuel. But here Nature seems to adapt her gifts to the need of the recipients, since

the American oils flow in the heart of the forests, while in Central Asia the oil-fuel makes existence and travel possible.

As regards quantity, in the year 1872 only 212,000 barrels were saved from the waste at the Caspian wells. In 1881 the amount rescued was 4,000,000 barrels, equal to 160,000,000 gallons. In the same year America produced 1,450,000,000 gallons. Commenting on these figures, Ludwig Nöbel says that the same amount could annually be produced at Baku without the slightest difficulty, but that at present it would be useless to do so, owing to difficulties of cheap transport. As it is, great stores lie waste for lack of purchasers, and the amount wasted is fully equal to that which is exported.

As regards price, which in America has varied from tenpence to one penny per gallon, it has at Baku fluctuated from one shilling and eightpence to one penny. In like manner, the barrel of forty gallons of crude petroleum, which in the days of monopoly sold at Baku for eight shillings, has latterly fetched fourpence, and by the latest accounts was further reduced to threepence halfpenny per ton on the spot! This is due to the enormous increase in the supply. Thus, last November a steady-going old well, which for the past ten years has been quietly yielding a fair amount of oil, suddenly commenced to play, and thenceforth threw up a daily average of five hundred tons!

The supply is apparently altogether inexhaustible, for already twelve thousand square miles in this region have been proved to be oleiferous, and of this vast surface only six miles are as yet being developed. The oil-bearing stratum is found to extend beneath the Caspian Sea, where it crops up in Tcheliken, a true isle of oil, which literally streams into the sea from hills and cliffs which are entirely formed of ozokerite—in other words, of crude paraffine.

On the eastern shore of the Caspian it reappears at Krasnovodsk and elsewhere. A hundred miles inland lies the Neft, or Naphtha Hill, whose deposits are officially valued at £35,000,000 sterling—oleonapht, as this particular material is called, being found especially valuable for lubricating machinery; so it promises to become an important article of export.

The oil-bearing stratum also reappears in the opposite direction; for as Baku lies at the eastern extremity of the Caucasus range, so at its western extremity, on the shores of the Black Sea, lies another great petroleum-region in the river-basin of the Kouban River, in the province of the same name. This oil-field, extending over about two hundred and fifty miles, terminates in the peninsula of Taman, between the Black Sea and the Sea of Azof—a strange region, abounding in mud-volcanoes, some extinct, others still active, which, combined with strong outflows of gas and occasional earthquakes, prove subterranean action to be only quiescent.

The natural petroleum-pits are scattered in all directions; some lie

in deep valleys, others nearly nine hundred feet above the sea-level. In some places the gas bubbles up through pools and lakes, which are covered with a rainbow-tinted scum; in others, the thick oil oozes from rock-crevices or bubbles up in mud-volcanoes. In some valleys there are regular terraces of a thick paste resembling asphalt, and smelling of petroleum. Rich deposits of ozokerite and flowing wells of petroleum have been partly worked, and it is noted that the oil here is of a yellowish-green color, while that at Baku varies from very dark green to transparent lilac. These Kouban deposits are as yet quite undeveloped, but it is evident that, from their local position on the shores of the Black Sea, they must soon attain to considerable importance. In all this region the character of the soil differs essentially from that of the oil-region of the States; here layers of solid limestone are comparatively rare, and the general formation consists of thick layers of clay, sand, quicksand, and sea-shells, telling of a period when the whole formed the ocean-bed. The methods of drilling and pumping have, of course, been adapted to suit these different conditions.

While Ludwig Nöbel continues to be the acknowledged oil-king of the Caspian, his marvelous success has given a tremendous impetus to the whole life of the oil-trade, and numerous capitalists have pressed forward to follow in his footsteps; so that Baku has rapidly developed into a large city, having a coast-line of about six miles sweeping round a well-protected harbor, crowded with shipping. At the close of 1882 the Russian papers noted this increase of shipping as altogether marvelous, seven thousand vessels having cleared the port within the previous six months, and of those fifteen hundred were actually Caspian vessels, chiefly hailing from Baku itself. Of course, many of these were merely small sailing-vessels; but no less than seven hundred steamers are now employed on the regular passenger and freight service of the Caspian and Volga, and some of these are splendid vessels, one at least being lighted throughout with Edison's electric lamps.

These are quite apart from the large and rapidly increasing oil-fleet. In addition to those belonging to Messrs. Nöbel, a Russian company (the Caucasus and Mercury Company) owns nineteen steamers, and other firms possess many, and are rapidly importing more and more from Finland and elsewhere. Forty new steel steamers, specially fitted with great tanks, were to be delivered to various firms before the close of 1883, and several hundred sailing-vessels have been constructed for the same purpose.

For the accommodation of all these, twenty-five piers have been run into the harbor, many of them fitted with pumps and pipes, in order to fill the great cistern-steamers with the least possible delay. Sixty miles of pipes connect these piers and refineries with the wells.

The most notable feature of all these steamers is, that they are worked entirely with oil-fuel. Newcastle coal will soon cease to find a market on the Black Sea or the Mediterranean—it may even be driven out of the Red Sea, as the use of petroleum refuse in engines becomes better understood. Already it is the only fuel in use on the Caspian, either in the mercantile marine, in the Russian gun-boat flotilla, or on the railways. Even in domestic stoves it is in favor throughout the Caucasus—all government offices in the neighborhood are thus heated—and the people are greatly encouraged in its use, with a view to saving the fast-decreasing forests of the Caucasus.

At present much oil refuse is poured into the sea as the only way to dispose of it, and yet its value as fuel is fully established; for whereas ordinary coal-burning steamers require to devote nearly half their carrying capacity to stowing fuel, those burning oil-refuse find that petroleum gives out twice as much heat as an equal weight of coal, so that they only require to carry half the quantity. The petroleum also requires far less constant attention from stokers than ordinary fuel. No stoking is required, no banking of fires—the whole thing is simple as a gas-stove, and one man can easily manage the simple apparatus composed of two tubes, through one of which trickles the petroleum, while through the other passes a jet of steam, which converts the oil into a spray so inflammable that it ignites, forming a great sheet of flame, which can be regulated at will—and thus steam is always ready at the exact pressure required, and labor and expense are reduced to the minimum. The advocates of coal declare that this fuel produces much heavy smoke and a tarry deposit, and also that it is liable to explosion. All this, however, depends on the refining, which will become more and more perfect as the value of each separate ingredient is more fully realized.

For instance, it is found that the dark waste fluid left after distillation contains four times as much gas as common coal. This has therefore been turned to account, and Messrs. Nöbel, having obtained a government monopoly in the lighting of the town for forty-nine years, have already established two thousand gas-lamps. They have also devised a new process for making candles of kerosene and solid oil for exportation. Soon they purpose turning their attention to the beautiful dyes to be obtained from the refuse tars, which they hope to turn to such good account that Baku shall be known throughout the world for the excellence and cheapness of its colors. Nöbel prophesies that it will become the world's emporium for cheap and beautiful paint in addition to all its other products.

ODDITIES OF ANIMAL CHARACTER.

MR. J. S. MILL, in his essay on "Liberty," long ago warned us against the stupefying influence of custom upon human beings, and held that we ought to encourage eccentricities in each other, and to guard jealously the right to be eccentric, instead of insisting on reducing every one by the hard-and-fast Procrustean standard to a single dead-level of mediocrity. But, whatever our sins may be in this respect toward human beings, surely they are greater still toward the domestic animals. We reduce our horses, so far as possible, to the mechanical condition of locomotive-engines—indeed, eccentric horses might involve very serious dangers to life and limb—our dogs to sentinels, which we drill to a social decorum as rigid as our own; while we regard the eccentricities of a cat with undisguised horror, as the mere prelude to dangerous insanity. No one who watches can fail to see how bigoted we are against anything like a "new departure" among our poor relations. If a man begins to save against his old age, we call it thrift, and praise him as a small capitalist who is giving hostages to fortune; but if a dog accumulates a store of bones or food, we look upon him as indulging in dangerous caprices, which may end in the necessity of putting a bullet through his head. There may be exceptions here and there. Sometimes you will find an old lady who will protect eccentricity in a parrot, a magpie, or a jackdaw, as a bird that has a right to a certain freedom of movement in return for its entertaining attempts at conversation. But, on the whole, there is no sterner standard of conventionality than that which we enforce on our domestic animals. Pet dogs become perfect bigots in favor of the usual, and persecute any attempt to deviate from it on the part even of a more powerful and less favored colleague, as the Inquisition persecuted heresy, or as the court of Russia persecutes Nihilism. There is nothing equal to the indignation of an in-doors dog at any invasion of the privacy of the drawing-room by an out-doors dog, and nothing more melancholy than the servile apologies which the big dog will make to the little one, for even proposing to break through the animal etiquette of the house. The horror of the queen's chamberlain, when once an officer presented himself at the *levée* in the proper court suit diversified by slippers, which he had forgotten to exchange for the regulation boots, was not so great as the horror of the terrier and the Pomeranian when a collie or a setter presents himself on the threshold of their mistress's sitting-room. We smother the genius of our dogs with our conventionalisms, and stifle the originality of our cats with luxurious bribes. We did, indeed, meet the other day, within the precincts of a great cathedral, with a young cat who was spoken of as "epoch-making"—as likely even to originate a new hegira by the

fervor of his genius. But even of his great promise we could gather no articulate account. He was still in the period of early youth, and perhaps was brooding over the designs by which he hoped to transform, in some future day, the world of the cathedral close. But, as a rule, it is certain that we teach our domestic animals as the Cingalese teach their tame elephants, to discourage steadily and effectually everything like eccentricities, whether deliberate or capricious, or assertions of liberty, on the part of their wilder colleagues, and so drill them into our dead-level of habit.

What important variations of character, however, might we not promote if we took more pains to foster what a writer of thirty years ago used to call "the individuality of the individual" among our friends of the lower races! Sir John Lubbock thinks that he has partially taught a poodle to read, but, as a correspondent of ours once suggested, that may be a step in the wrong direction—not a development of the true genius of the dog, but an attempt to merge the genius of the dog in habits peculiar to man, and likely rather to result in ingrafting an imitative humanity on a totally different kind of capacity. On the other hand, in his experiments on ants, Sir John Lubbock has gone on the sounder principle of setting the ants problems to solve for themselves—a principle which has resulted in showing that different races of ants have very different resources, and that different individuals, even in the same race, show a very different amount of resource in dealing with the same difficulty. This is confirmed by what we know of our more intimate friends among the domestic animals ; and surely we should do more to develop their capacity by stimulating them to meet difficulties by their own resources than we can effect by taking their training so completely under our own care. Is it not possible that, as things go, the companionship of man is rather an incubus on the natural genius of the inferior animals than a help to its development? It is clear that the ants, at least, are more sagacious in proportion as they live more apart from man, and are thrown upon their own resources. The harvesting-ants of Texas and the leaf-cutting and military ants of Nicaragua are far higher in civilization than the ants of the more densely peopled countries of Europe. In proportion as they have a freer scope for their efforts, their social communities appear to be founded on a more advanced intelligence and organization. Is it not possible that we stunt the intelligence of our humbler fellow-creatures by doing so much for them, and permitting them to do so little for themselves?

Certainly there is far too little disposition to allow of eccentricity in the lower animals and for what comes of eccentricity. Half-domesticated birds, however, will occasionally show very remarkable eccentricities, and even appear to be making experiments—though experiments which we should, of course, regard as of a very unscientific kind—in the modification of their own instincts. The present writer knows

a pigeon of exceedingly eccentric disposition, not unlike "the single gentleman" in Dickens's "Curiosity Shop" in his habits. He keeps seven pigeon-boxes all to himself, and persecutes relentlessly any pigeons which propose to share their dwellings with him. He is as averse to the society even of the gentler sex as was St. Anthony himself in the Egyptian deserts. Not a pigeon will he admit within the circle of his sway. And yet, in spite of this resolute and inveterate bachelorhood, this eccentric pigeon is always endeavoring to build nests, and looking out for objects of an egg-like form, which he thinks it possible to hatch. He will accumulate twigs and straws now here, now there, at very great pains and labor. He will coo sometimes to inanimate objects, sometimes to captive birds of another breed, sometimes to a kitten or a dog, or even a flower-pot, with the quaintest and politest antics. He will sit patiently on china-saucers on the mantelpiece of one room, while he accumulates the materials for a nest on the top of a closet in another room. He does not even drive away the possible mother of a family with more zeal than he shows in seeking to be a good father to some imaginary chick which he seems to expect to elicit from a ring-stand or a letter-weight. So far as the present writer can judge, he is a pigeon of strong Malthusian views, who hopes to inaugurate a new *régime* which may have the same relation to the ordinary habits of pigeons which the Positivist worship bears to the other religions of the world. He hopes to foster and cultivate the family and parental idea without any corresponding reality, without any aid from outside, indeed, except an apparatus of external ceremony, which feigns the existence of a purely ideal mate, and affects to indulge in the expectation of impossible offspring. Doubtless he thinks that there is nothing so good as the courtly attitude of a pigeon toward his mate, especially if there be no mate to justify it; nothing more touching than the patient preparation for offspring and the education of the young, especially if there be no young to complicate the problem of tenderness and foresight, by requiring a real supply of food and attention. This eccentric pigeon seems to be a solitary thinker of the Comtist kind, who hopes to solve the problem of preserving to the full all the higher instincts of bird-life, without the difficulties involved in supplying those instincts with real objects. If a human thinker can empty religion of its meaning, and yet justify all its forms and sentiments and external rites, and if he is to receive nothing but praise for his achievement, why may we not regard with interest and admiration the effort of an eccentric bird to retain all the ceremonial forms of chivalrous observance and elaborate parental care and patience, without, in fact, complicating the situation by admitting the neighborhood of either wife or child? To our mind, the idiosyncrasies of such a creature as this deserve the most attentive study. Who knows whether we might not find in the world of eccentric instinct all sorts of anticipations of eccentric intellect? Who knows

whether we might not find genius and originality in other races of animals which would throw as much light upon the genius and originality of man as the eccentricities of this pigeon seem to throw on the eccentricities of a most active and confident school of modern thought? If John Stuart Mill were right in thinking it a sacred duty not to discourage the milder lunacies of human beings, might we not with equal advantage extend his exhortation, and make it include the duty of protecting the independent development of the idiosyncrasies of bird and beast, in the hope of finding in them some clew to the various oddities and harmless insanities of human thought and action?—*Spectator*.

BIOGRAPHICAL SKETCH OF E. B. TYLOR.

AMONG the most prominent of the British scientists, attracted to the recent meeting at Montreal, was the President of the Anthropological Section, Edward Burnett Tylor. He is well known as a distinguished author on the early history of the races of mankind, and his investigations of this comprehensive subject entitle him to an eminent rank among the founders of the recently established science of anthropology.

He was born at Camberwell, about four miles from St. Paul's Cathedral, London, on October 2, 1832. He was of Quaker parentage, and was educated principally at the school of the Society of Friends, Grove House, Tottenham. He was a fair classical scholar, and had mastered the differential calculus, when at sixteen he entered his father's manufactory in London, with the intention of pursuing a business career. But at twenty, soon after the death of his father and mother, symptoms of consumption, or what became dangerous symptoms, appeared. He then traveled in the United States and Mexico for two years to recruit his health. On his return to England he had a severe attack of phthisis, and his case was several times declared hopeless by eminent physicians, but, after spending several winters on the Riviera, he partially recovered. He was then advised that he might marry, and this completed his restoration, his wife taking excellent care of his health. He is now a strong, broad-chested man, six feet high, in the full enjoyment of mental and bodily vigor.

Dr. Tylor was not a university man, and the circumstances which turned his attention to the department of knowledge to which he has devoted himself and the influences by which he was impelled to pursue it are interesting. He entered into scientific life under unusual advantages, having the opportunity of meeting many eminent scientific men

at home, as his elder brother* was an active geologist. His family resided near that of the late R. Philipps, a well-known chemist, and brother of W. Philipps, the mineralogist; and it was mainly through the influence of the Philippses that the Tylor family received its early scientific bias. When residing on the Riviera, at Cannes, he made the acquaintance of Lord Brougham; Mr. Bellinder Ker, a Whig politician, whose father wrote a work on philology; Mr. Hope, who left a large collection of natural history objects to Oxford; and Dr. Falconer, the eminent paleontologist. Young Tylor traveled in Mexico with an old and experienced collector, Mr. H. Christy, to whom everything that was unusual (by whomsoever found) was an object to be carefully preserved. As Christy had been trained by the late Dr. Hodgkin, one of the founders of the Aborigines Protection Society, to interest himself in everything relating to aboriginal man, so Christy trained Tylor to regard nothing as trivial that had any bearing on the mental states of savage men. No preparation could be more invaluable than this for the work of investigation—the collection, analysis, and interpretation of facts—to which Mr. Tylor has since given his undivided attention.

The stimulus of intercourse with cultivated minds is a factor of great moment in determining the career of able young men, and Mr. Tylor seems to have been especially fortunate in those intimate and early associations which depend upon social circumstances. Like Dr. Young the physicist, and Dr. Dalton the chemist, Mr. Tylor came, as we have said, of Quaker parentage; and Sir J. Lister, his schoolfellow, and also his predecessors, Hodgkin and Christy, were Friends, and the Philippses were also born members of the society. Under such favorable associations Mr. Tylor pursued his systematic studies, acquiring a fluent mastery of most of the European languages, and a considerable acquaintance with a dozen more. Without these acquirements he could not have done his work in comparative ethnology, as old translations, made before ethnological science was developed, were not only often useless, but actually misleading.

Dr. Tylor's first work, "Anahuac; or Mexico and the Mexicans," written at Cannes after his return from Mexico, was published in 1861. It gave not only the important results of especial investigations and excavations in Mexico, but it embodied the germ of a new department of the new science of anthropology. As the author was not then much known, and was dealing with a subject still comparatively undeveloped, and perhaps also from its unfortunate title, it did not meet with a success at all proportionate to its undoubted merits. His "Researches into the Early History of Mankind" appeared in 1865, and

* Mr. Alfred Tylor published his first important geological paper in 1852, in "Silliman's Journal." The views it contains, though much opposed at the time, have been quoted by A. R. Wallace in "Island Life," by Professor Huxley in his "Physiography," by Darwin in his book on "Earth-Worms," and by Sir Charles Lyell in his text-books.

was the work which made his reputation. It showed great research, original insight, much constructive power in the formation of systematic views, and a high degree of literary merit. It at once took a position as a standard treatise upon the subject, was translated and republished in different countries, and contributed largely toward the diffusion and acceptance of more rational views on the subject of the earlier and the lower races of mankind than had hitherto prevailed. "Primitive Culture: Researches into the Development of Mythology, Philosophy, Religion, Art, and Custom," appeared in 1871, in two volumes. This was a much more comprehensive work than the former, pursuing the same questions to a more amplified and exhaustive treatment.

The latest considerable work of this author, an educational handbook of the science of man, entitled "Anthropology, an Introduction to the Study of Man and Civilization," was published in 1881. This is undoubtedly the best book upon the subject in our language. It is not a large work, but it condenses an immense amount of information with great skill, so as to bring the exposition into shape for general readers who have no time to peruse and digest ponderous volumes. Dr. Tylor is a very amiable man, and, without saying that he is fastidious and timid, he is undoubtedly solicitous to give the least possible offense in his statements. To show how careful he is to avoid irritating even persons of very confined ideas, it has been remarked that the word "evolution" only occurs once in the "Manual of Anthropology," although the book is broadly based upon that fundamental idea.

Dr. Tylor is an excellent lecturer, and has frequently delivered discourses before learned societies, like the Royal Institution of London, which have been widely published, and are always marked by originality, terseness, and interest. He has contributed to periodicals and encyclopædias, and is a hard worker. He is well known as the author of the theory of animism, and it is claimed that he first introduced or made current the term "survival," now so commonly applied to those vestiges of early habits and ideas which linger on as anomalies long after they went out of their primitive use.

Our author was elected Fellow of the Royal Society in 1871, received the honorary degree of LL. D. from the University of St. Andrews in 1873, and a D. C. L. from the University of Oxford in 1875. He is President of the Anthropological Society, and in March, 1883, he was appointed Keeper of the Oxford University Museum, and in the same year the degree of M. A. was conferred upon him by decree of the House of Convocation. He has also been made reader in anthropology, it being the first provision made by the University of Oxford for teaching that subject.

CORRESPONDENCE.

MORE ABOUT THE BEAVER.

Messrs. Editors:

I HAVE been highly entertained, and gained some new ideas, by reading Dr. Stockwell's article on "The Beaver and his Works" in the "Monthly" for May, 1884. I have myself long since made the acquaintance of the beaver, but in different regions from that studied by Dr. Stockwell. Perhaps that is the reason why my observations in some particulars differ from his. The beaver has, or had, such a wide range, and has been subjected to such different and ever-changing environment, that it is not at all extraordinary if his habits changed and differed more or less in widely separated localities. The doctor remarks that modern science has disproved the statements that the beaver used his tail for a trowel and as a vehicle for transporting loads. How has "modern science" disproved these statements? Has it not been, only, by the failure of some later naturalists to observe the beaver's habits which were reported by older observers? Hence, they assumed that, what they had not seen, no one else ever saw, and on such negative evidence the genius of the beaver has come to be underrated. I will venture to suggest that no modern naturalist has seen quite all the beavers at work, nor examined quite all the beaver-dams, that existed during the last fifty years. Great variation in habits of life in an animal as intellectual and full of resources as the beaver might be expected during that process of persecution to which it has been subjected, and which has reduced its numbers more than a thousand-fold.

In the summer of 1865, while resting late on a cloudy, sultry afternoon near the banks of a stream south of the Niobrara, in Northeastern Nebraska, I had the gratification of seeing a singular beaver-performance. I was sitting on a fallen tree, when I heard a peculiar noise over a rise beyond me. Creeping to the top of the slight elevation, and peeping over, I saw a dozen beavers rolling a small log or thick pole of cottonwood in the direction of a stream. A few were pulling in front, but most of them were pushing from behind. Finally they rolled the log into a shallow depression, whose farther side was much steeper than the side from which they brought it. Their united strength was insufficient to roll it out of this depression, and it was most curious to watch the various manœuvres to accomplish this purpose. First they cut off about eighteen inches of the thick end, and then made another attempt, and again failed. Then they came together almost in a circle as if for consultation. Suddenly they separated, went back to the log, and rolled it about sixteen inches back in the direction from which they brought it. Five of the beavers now went in front, stretched out their tails toward the log, when those behind rolled it on the tails of those in front. The five beavers in front now pulled, those behind pushed, and in a few minutes the log was drawn out of the depression on to comparatively smooth ground. When this was accomplished the imprisoned tails in front were released, and the tails were handled and examined as if they were hurt. Rolling was then resumed. This satisfied me that the stories which I had heard from trappers and Indians about the beaver sometimes using his tail to move burdens was correct.

Again in September, 1870, while attempting to cross a tributary of the Logan River in Wayne County, Nebraska, on the breast of a beaver-dam, owing to a "circus" commenced by my mules, a small portion of the left side of the dam was damaged. Camping near by at dusk, I hid myself among the tall weeds, and waited for developments. The beavers soon appeared, and commenced the process of repair. They carried weeds and mud, and closed up even the tracks left by the mules, and smoothed down the sides of the dam. In doing this, I could distinctly see one, but only one, draw his tail backward and forward over the freshly placed earth and mud.

It is a mistake to suppose that the beaver only resides in or near wooded districts. At the time of which I speak there were still beaver at work on tributaries of the Logan, where there was no timber growing of any kind within twenty miles. In these places they built their dams of tall sunflower-stems, and the stems of other plants that grew luxuriantly on and near the banks. They laid the stems in the water, mainly lengthwise, up and down the stream, bound them together with mud, and made them amazingly strong.

In regard to the manner in which the beavers cut down trees there is some variation. A few years ago in Middle Park, Colorado, I measured the stumps of forty-two trees that were cut down at various times by beavers. In all these cases, except one, the gouging was done to near the center, equally on all sides. In the one exception the cutting was done beyond the center on one side, and only one fifth as far on the other. In Northeastern Nebraska, where, during seven years, I measured stumps of

trees cut down by beavers as opportunity offered, out of two hundred and seventeen measurements of trees, from two to eighteen inches thick, seventy-nine were cut equally on all sides; ninety-two were cut from one fourth to one half inch farther in on one side than the other, and forty-six considerably exceeded this difference. I do not know the cause of this variation, but suspect it comes from attempts to fell trees in certain directions.

Even the houses of the beavers are subject to occasional variation. When going through some of their dwellings in a beaver-dam north of Grand Lake, Colorado, I was struck by one exception to the type-form described by Dr. Stockwell. It had two distinct stories, the lower being partly under water, and partly filled with twigs of quaking-asp. The upper story had the rough walls smoothed inside by having every crevice filled with dead leaves, the whole being almost as smooth as the interior of a bird's nest. I examined many other beaver-houses along the Grand and the tributaries of Grand Lake, but failed to find any that were as elegantly fashioned in the interior as this one.

The facts detailed that came under my observation have confirmed me in the heretical opinion that the older observers, who studied the beaver at close range, drew as little for their facts on their imaginations as the modern naturalists.

SAMUEL AUGHEY.

LINCOLN, NEBRASKA.

CURIOUS CHANGE OF HABIT.

Messrs. Editors:

THE following sketch of a change of habit in a species of snake, the *Liopeltis vernalis*, will doubtless prove interesting to some of the many readers of your valuable "Monthly":

A week or two ago, while walking in the garden, my attention was attracted by the curious actions of the cat, which seemed to be suffering from an epileptic fit, jumping, rolling, and scratching at a great rate. A closer approach revealed that he was busily engaged in trying to throw off a beautiful green snake (the *Liopeltis vernalis*), which in its efforts to escape the claws of its foe, had coiled itself around the cat's body, much to the latter's discomfort. There was no apparent effort at constriction made by the snake, who was evidently waiting for a good chance to escape. Finally, the snake uncoiled itself and tried to seek safety by flight. It was caught, however, while crossing a wide path between the bushes, and handled unmercifully. While struggling under a lilac-bush, about six feet high, a sudden thought, born of necessity, seemed to animate the snake. It twitched itself loose from the grasp of the cat, made for the slender trunk of the lilac-bush, or rather shrub, encircled it, and in a few seconds had made its way to the very top of the shrub, across which it lay extended, watching the futile endeavors of the cat to climb the slender stem of the shrub. After repeated failures, the cat lay down at the foot of the bush, like a tiger waiting for his prey. The resemblance was very striking, the cat being of a tawny gray color with dark bands, a perfect tiger *en miniature*. This blockade continued more than an hour, when the snake took advantage of the momentary inattention of the cat, and quietly glided on to the tops of the adjoining gooseberry-bushes, until he had put about ten feet between his foe and himself. He then glided to the ground, and made his escape, unmolested, much to the grief of my little girl, who wished to have the beautiful little reptile as a pet. The cat continued his blockade for some time longer. He could not be coaxed away until I took him up and held him among the top branches of the shrub, letting him see that the snake was gone.

While every snake has sufficient sense to take hold of anything on which it may be placed, it is very rare for the ordinary ground-snakes to so forsake or modify their terrestrial habit as to voluntarily seek protection above the ground, and thereby cultivating an arboreal habit. This same specimen, under similar circumstances, will, without doubt, pursue a similar course of action, and in time produce a race of terrestrio-arboreal *Liopeltis vernalis*, which, having an advantage over their less highly gifted brethren, according to the principle of the survival of the fittest, should become the final normal type of *Liopeltis vernalis*.

G. A. BRENNAN.

ROSELAND, COOK COUNTY, ILLINOIS.

EXTENT OF THE RECENT EARTHQUAKE.

Messrs. Editors:

BEING interested in science, permit me to say that if you, or any one, proposes to collect facts relative to last Sunday's earthquake, I am quite sure it was felt here. During the afternoon I experienced a strange and unwonted quiver in the floor of my study and a slight movement of the window-sash. It drew my attention at the time as something different from what I had ever observed before. My room is so situated that no movements of persons about the house can shake the floor, and I am certain it was the earthquake. I neglected to note the time, or to suspect the probable cause, being very busy. But another member of my family noticed a strange movement in the house, and crackling sounds in the ceiling of another building were heard.

It is stated also to have been felt at a point twelve miles south of here. This place is eighteen miles south of Rutland, and we call it about two hundred and fifteen miles north of New York by rail, and the railroad route is quite direct—certainly near two hundred. L. D. Mears.

Danby, Rutland County, Vermont, *August* 13, 1884.

SCIENTIFIC PHILANTHROPY.

Messrs. Editors:

I have just read "Scientific Philanthropy," in the August number of "The Popular Science Monthly." While I agree with the general tenor of the article, yet I wish to make objection to some of the statements.

Sociology is getting to be an exact science; and those who wish to write upon it will have to be much more careful as to what they assert than they have been in the past. All positions are criticised, and nothing will pass but what is true at all times, under all conditions, and in all circumstances.

Mr. Vance says, page 482, "With successive differentiations of individual functions and pursuits, there comes an increasing specialization of each differentiated member of society, and hence industrial virtues and vices, which the parent fixes for the child by heredity, lead to the existence of two very different classes in community—the rich and the poor, the strong and the weak, the rulers and the ruled."

Now, so far as certain industrial virtues or vices fixed by heredity being the source of the two classes, the rich and poor, the rulers and the ruled, I for one entirely deny.

Those classes, as we know them now, are maintained by certain social institutions that give special advantages to those in possession, and prevent others, however possessed of all necessary virtues, from reaching the place for which they were fitted. Of that there are so many proofs that there is only the difficulty of choice.

In England, advancement in the army is only possible to a certain class. In France, where class distinction was abolished, the best officers of the Revolution rose from the ranks.

In the United States, where chances are more equal, it is the common observation that men who come here with money lose it, those who come poor become rich. Does any one suppose that Vanderbilt would be the rich man he is, or Bennett own the "New York Herald," if they had depended upon their inherited virtues for their possession?

But that which can be easily proved is that when a man has reached the upper class, either of riches or rulers, he next strives to pass to his children, not the virtues that brought him there, but the results of his labors; and not only to pass them, but to so arrange matters that the benefits may not be squandered through any follies of theirs.

And when not one man, nor one thousand, but untold generations strive in one special direction, the result is not difficult to perceive.

This result is a class of rich and of rulers that not only hold possession, but who have so intrenched themselves that it is almost impossible to dislodge them, and the battle that is coming on is simply one to equalize the chances, so that the parents will have to transmit the virtues as well as the possession.

There is an undercurrent, deep and strong, that will make itself felt some day before long. Mr. Ward's book, "Dynamic Sociology," is a precursor of it. Those who would check it must be more accurate than the general run of writers on "sociology."

Mr. Vance says, furthermore, page 493; "The sentimentalist employs in sociology the empiric method; in ethics, he builds upon intuition; in political economy, he favors the principle of co-operation."

It may be true of the sentimentalist, but the natural inference that those who favor co-operation are sentimentalists is a great mistake. The principle that works in favor of co-operation is to avoid the immense waste of competition.

Albert Chavannes,

Adair Creek, Tenn., *August* 16, 1884.

EDITOR'S TABLE.

SCIENCE IN SCHOOL MANAGEMENT.

The progress of popular education is gradually bringing into prominence a class of questions of fundamental importance, the existence of which was hardly recognized in its earlier stages. It seemed at first a very simple affair to organize a common-school system, and nobody anticipated that any very serious difficulties could arise in carrying it out. Children were to be taught the rudiments of knowledge—chiefly reading, writing, and ciphering. There was but little trouble

in finding teachers competent for this work, and no trouble at all in finding any number of men held abundantly qualified to be directors, trustees, managers, and superintendents of such education.

But the system was no sooner entered upon than it began to undergo a series of changes which were, of course, characterized as improvements. There were at first much crudeness, laxity, and irregularity in the schools, and these were to be replaced by better order and closer and more methodical work. The scope of instruction began to widen, and new subjects were introduced. Courses of study were laid out requiring years to complete them. The pupils were classed and graded, and this necessitated the gathering of larger numbers in the same establishment. Lesser schools were absorbed under the policy of expansion. With more diversified study, a complicated system of examinations, markings, and promotions grew up, which required a special apprenticeship of the teachers to work in it. The department of normal schools was instituted to meet the new demands on teachers, and, as the system was regulated by State authority, it was reduced to constantly increasing uniformity in all details of management.

In this way the public schools underwent a radical change, by which what had no existence at first gradually came to be of supreme importance. Liberty on the part of both teacher and pupil disappeared, and they became the passive subjects of inflexible regulation. Rules grew sacred, and there was no sin so great as to be absent from school a day, or not to be promptly on hand at the moment for starting. The officials directed everything, decided what and how much to study, hours of attendance, recesses or no recesses, and put as much or as little pressure as they pleased upon school operations. As a consequence, a gigantic mechanical system was created, the perfection of which consisted in the mechanical element. There are many who think that the system is now essentially perfected, and that, to gain its highest advantages, nothing remains but to augment its resources, and drive it with increasing vigor. Yet experience is disclosing grave difficulties in its working, and difficulties, moreover, which spring out of the alleged perfections of the method. That which characterizes it is the completeness of organization for dealing with pupils in masses; and the vice which is now widely recognized in its operations is, that the individuality of pupils is sacrificed to the perfect working of the mechanical arrangements.

Of course, in the nature of the case, the greater the number of children operated upon, the less is the consideration that can be given to each personality. Children are treated by a plan which implies that they are alike, but the assumption is not true. They are unlike, the differences among them are great; and, when it comes to the processes of education, these differences are fundamental. The fact which is neglected in machine education is the most important fact of the case. The palpable differences in physical aspect by which each is known as an individual extends through the whole nature. Children differ widely in their mental faculties, in their capacity of apprehension and retention, in aptitude for different kinds of mental effort, in quickness of perception, in moral sensibility, and power of self-restraint, in organic soundness, and the capability of endurance. To cultivate them all alike is to do violence to those peculiarities which make up the individuality. They can neither be taught in the same way with the same results, nor plied by the same motives with equal effect, nor subjected to the same degree of strain without injurious consequences. Say what we will, there in an undoubted antagonism between the necessities and rights of individual children and the inexorable

grind of the great educational machine; and experience testifies that the policy of ever-increasing stringency of requirement to which the mechanical system tends only aggravates its evils. In this respect there is nothing self-corrective in our educational methods.

It is not to be denied that a main root of this evil is the incapacity of teachers and of those intrusted with the management of schools to judge intelligently of the results of their system upon the varying natures of children. This is a complex and extensive branch of knowledge to which the normal schools give little attention. Our teachers as now prepared, and our school-officers as now selected, are left in ignorance upon this subject. Instructors are trained in the matters they are to teach. They are drilled in all the petty niceties of preordained school-room studies, and disciplined interminably in all the technical processes of the school system. Superintendents, inspectors, and boards of education are frequently mere business men, often men who have failed in some profession, and sometimes promoted teachers, and that they should know nothing of those physical, mental, and moral characteristics of the children subjected to their charge is inevitable.

And obviously, under the present policy, they can never possess this knowledge. The time is all taken up with other things, the machine is in the ascendant, and the results aimed at must be such as will commend themselves to an ignorant public sentiment. The thorough scientific study of the natures of children, which would qualify a teacher to judge of their differences, and the unequal influence of the system upon them, whether for good or for evil, could only be brought about by a radical reconstruction of the whole method, and the rejection from it of a great deal which is now held of supreme importance. No such profound change is to be expected. There is, therefore, little hope of relief from existing difficulties by any special preparation of teachers for the purpose. And, even if the policy were entered upon, it is extremely doubtful if it could be developed and carried out for many years in any adequate way; and it may be probably laid down as wholly impracticable to qualify the mass of teachers to judge intelligently of the effects of their educational system upon children, even in the single particular of over-pressure, and its influence upon mental and bodily health. Perhaps a few teachers could be specially trained in this direction, so that some degree of intelligence might be brought to bear upon the school-room regimen; but even this is impracticable in the present state of thought upon the subject.

What, then, remains to be done? Is the most important measure of improvement in school management to be given up as forever hopeless? We have said that this defect of our school system is attracting serious attention, and calling forth sharp criticism, but is this to avail nothing for future relief? We are not driven to this alternative, for the sufficient reason that there are men in the community well prepared to deal intelligently and efficiently with the subject. It is the especial business of medical men to understand the human constitution, and all their knowledge relates to what the school system ignores—the peculiarities of the individual. Diagnosis, critical personal observation, is the basis of all medical practice. Moreover, there is an especial branch of medical study that bears directly and immediately upon the questions here involved. There are physicians who give their lives to the investigation of mental science with reference to its corporeal conditions and its problems of health and disease. They are the students of insanity, and all the causes which tend to undermine mental soundness and produce feeble-mindedness in its innumerable forms. These are the men prepared to judge of the working of a school system upon

the natures of children, and it is impossible to see that any reason can be offered for not invoking their services to this important end. Yet, strange to say, our school authorities are the first to resist this reasonable policy. They resent the idea that their system is not already working in perfection, and they virtually maintain that the ignorance of teachers and school officials is just as good for practical guidance as the knowledge and experience of men especially cultivated to deal with cases which are constantly arising, where pupils become the victims of an undiscriminating high-pressure system of school-work.

An illustration of the subject has recently arisen in London, which is attracting public attention in the shape of a controversy between an eminent medical man and a prominent Government official. Dr. Crichton Browne, a distinguished authority on nervous diseases and the treatment of the nsane, pointed out some of the evils attending prevalent school practices, and advocated school inspection by competent physicians. Mr. Mundella, a manufacturer, a philanthropist, and Vice-President of the Government Council, who has large direction of the school, took issue with Dr. Browne, and there came a public contention upon the subject. The London "Lancet" reviewed this controversy, and gave reasons for maintaining that Dr. Crichton Browne had the right of it. The subject is so important that we reprint the "Lancet's" remarks in full:

Leaving the personal issues involved in the regrettable dispute which has been raised by Mr. Mundella's equivocal mode of traversing Dr. Crichton Browne's report on the subject of "over-pressure of work in public elementary schools," we turn to the main question: Is it, or is it not, the fact that over-pressure exists, and that it is doing mischief? The case seems to us to lie in a nutshell, and it would be difficult to cast the underlying hypothesis in a more terse form than that embodied in one of Dr. Crichton Browne's concluding sentences. No one alleges, or for a moment supposes, that the Vice-President of the Council, or any influential member or official of the Educational Department, is either willful or careless in the matter. It is simply a question of policy; and the most that need or can be justly said is said in these words: "It is quite possible that a scholar, whose body is twelve years old, but whose brain stopped growing at eight, might by his pleasing exterior and superficial sharpness impress the inspector with the idea that he is rather clever, while all the time he is childish, not to say babyish, in intellect, and ineducable beyond the first standard." If this be conceded, as we think it must be, then it follows that the inspector is not in a position to determine whether a particular pupil is or is not physically able to do the work required of him or her, and fit safely to be pressed through the educational curriculum. This seems to us to cover every contingency. It is not necessary to argue closely or warmly as to the question of experiences. It is conceivable that not a single case of injury may actually have occurred, and yet the system which makes a non-medical inspector—however humane and competent for his *proper* task—the judge of physico-mental fitness, whether of pupil or pupil teacher, must be indefensible. What are we doing? Simply this: applying a uniform pressure to a vast multitude of brains, some of which must, in the nature of things, be too weak or too ill-developed to bear the strain thrust upon them. It is a monstrous and inexplicable blunder this insistence on a level code of education for *all*. Why, even as regards the muscular and general organism of the soldier and the sailor a medical examination precedes the commencement of drill, and medical inspection from time to time keeps the question of health in view. Muscular weakness is not half so serious a bar to physical training as mind weakness is to intellectual exercise. How comes it to pass, then, that without any medical examination or supervision whatsoever the brains of a multitude of children, the majority of whom are under-bred and ill-fed, should be subjected to the same discipline and required to do the same task? It is not considered enough to know the age of a recruit for the army or navy; means are taken to ascertain whether his heart, lungs, and organs generally are healthy, and medical officers are specially appointed to examine him from time to time with a view to determine whether he is bearing the strain healthily; but no provision whatever is made for testing or watching the immature cerebral orgasn

upon which the public pedagogue is not only left free, but required, to operate. The mere fact that this obvious measure of individual scrutiny, from the health point of view, is omitted, puts the case for the department out of court.

Dr. Crichton Browne insists that, "in a great number of cases of dullness of intellect, a medical man could at once recognize the physical defects (which are often distinctive enough, although imperceptible except to the medical eye) which accompany mental weakness, and would support the judgment of the teachers; and in many cases of bodily disease and debility he could interefere to protect the children, even against the teachers, by preventing scholars who, although quick-witted and eager to learn, are certain to suffer in the process from being unduly pushed forward." The profession will indorse this statement as one of fact, and with that indorsement the dispute ought to end. Dr. Crichton Browne has undoubtedly proved his case. It is not to the point whether the victims are many or few; the system extant is radically bad; and, that being so, the magnitude of the mischief wrought is of secondary importance. The blunder of striving to enforce a uniform code ought to be repaired without more ado. It may be strictly true, as Lord Shaftesbury has remarked, that "there does not live on the face of the earth a man who is more opposed to tyranny and oppression than Mr. Mundella, or any one more earnestly desirous of putting down all over-pressure as regards women and children." Then why, in the name of common sense, does not the vice-president adopt the suggestion made to him, instead of fighting what must needs be a losing battle against his own moral and statesmanly consciousness of right?

Headaches, short-sightedness, neuralgia, and sleeplessness are not normal contingencies of youth, either for pupil-teachers or children, yet it is a fact which Dr. Crichton Browne has demonstrated, and which men "engaged in the ordinary practice" among the humbler classes, and who, according to Mr. Fitch, are "able to know something of the children of the poor, their pursuits and their ailments," can substantiate, that these troubles—the direct fruits of over-pressure of work—largely prevail. Nothing can be gained by denying this fact, and certainly a lay inspector is not the person to contradict an able and experienced practitioner on the subject. Dr. Crichton Browne modestly says: "I can not doubt that many of the facts which I have brought before you in this letter will be disputed, and that many of the principles which I have incidentally laid down will be challenged; but the former admit of verification, and in the latter I shall, I believe, have the support of the medical profession." We accept the facts and support the principles. If Mr. Mundella is not satisfied with one of the best professional opinions obtainable, let him appoint a small commission of physicians and surgeons, men of mark, in whom he and the public will have confidence, but who are in no sort of way connected with the public service or the department, and let the issue be left in their hands. It is not for Mr. Mundella and his lay inspector to impugn the judgment of a qualified physician. The presumption of so doing does not beseem these gentlemen: it goes better with the crass heartlessness—to use no stronger epithet—of the school manager who, when a wearied mistress ventured to sit while teaching her class, ordered all chairs to be removed from the building! While the administration of our educational system rests in hands like these, there is little hope of success or safety in its operation. For the sake of children and teachers alike, the schools ought at once to be placed under medical supervision. In an able and interesting paper on "The Brain of the School-Child," read before the Social Science Congress at Birmingham, Dr. Francis Warner has insisted on the urgency of the need which exists for medical inspection. We cordially indorse and support his argument. It is the cry of common sense. If the reasonable demand be not met fairly and fully, there can not fail to be disappointment and regret when the inevitable issue of a mistaken and futile policy is fully worked out.

THE ABUSE OF POLITICAL POWER.

While Rome was burning, it is said, Nero fiddled. The merry crackle of the flames, the glaring and tossing of the fiery sea, stirred the irresponsible tyrant to mirth as he heard and surveyed it all from his lofty tower. The story may or may not be mythical, but in either case it has its value as helping to complete in our minds the true type of the tyrant. The tyrant is he who uses public power as a private possession—uses it for his own gratification and not as a trust—and who can, therefore, stand apart in the hour of public

peril, and laugh at commotions which, fraught as they may seem with possibilities of general disaster, he gayly hopes will not dislodge him, personally, from his position of vantage.

The old doctrine was, that there could be but one tyrant in a state, one usurper of power; but if it be agreed that the essence of tyranny consists not in the *extent* of power usurped and abused, but in the *fact* of usurpation and abuse, we may perhaps be led to see that there may be as many usurpers or tyrants in the state as there are depositaries of power. He that is unfaithful in a little would be only too likely to be unfaithful in much, if he had the chance; at any rate he is in the same position morally and socially as though he had been unfaithful in much: he has done evil to the extent of his ability.

Let us look at the word "usurp" for a moment. The common and, as we think, correct etymology represents it as compounded of the two words *usui* and *rapere*, "to snatch for (one's own) use." Certainly a very happy mode of expressing the essential characteristic of tyranny. We load with opprobrium the monarchies of the past because they snatched to their own use and advantage powers which they could only righteously have wielded for the general good. We exult over the successive revolutions by which personal rulers have been shorn of their powers; and we look forward to the time when democracy in the fullest sense shall be co-extensive with civilization. Then no man will be the depositary of any wide powers except strictly as a matter of delegation. Then the whole people everywhere will co-operate in the making, and largely control the execution, of the laws; and tyranny will forever be at an end.

The prospect is a cheering one, but the subject will bear a little closer looking into. Let us suppose that a certain monarch of past times—an Alfred let us say, an Edward III, a William III, or, going further back, an Antonine or a Trajan—finding himself in the possession of supreme power in the state, had faithfully endeavored, according to his best lights, to use that power for the benefit of his subjects, regarding himself as responsible to some higher power enshrined in his own conscience—could such a ruler, acting on such principles, properly be called a tyrant? His reply to the charge, were it made, would be: "I have not made a selfish or irresponsible use of power; I have not sacrificed others to myself, rather have I sacrificed myself to others; I have done my *duty* to the best of my knowledge and ability." Now the question arises, Can the individual citizen, who disposes of his ballot and his social influence, always say as much? If not, what are we to say of him? Are we to say that, because political power which was once possessed in the lump by one man has been broken into fragments and distributed to all men, all need for responsibility in the use of it has vanished? We fail to see it. Formerly one man had much, and he was required to be faithful in much; now each of us has a little—of the very same thing be it remembered, power, power not over ourselves only, but over others as well—and surely we are required to be faithful in the exercise of that little. If we are not, what are we but each a petty tyrant in his way—fragments of one big tyrant, *disjecti membra tyranni*, if we may be allowed to alter a well-known Horatian phrase.

The man who sells his vote for money, what is he but a usurper in the strict sense—one who snatches a public function, and applies it to his purely private advantage? What is he, again, but a traitor, seeing that, for money, he hands over the government, so far as he can do it, to a public enemy—the purchaser of votes being of absolute necessity a public enemy? Well, every man will not exchange his vote for

hard cash; but many a man, who has a soul above that particular form of transaction, sees no harm in taking an office as the equivalent of his franchise. Another wants his particular line of industry protected, and subordinates everything to that, without so much as a qualm or a misgiving. If his vote was not given to him that he might use it for the advancement of his business interests, he does not understand anything about the matter. Others give their votes as a matter of private favor; others, again, under the influence of private spite. Most have no better reason to allege than that their party has set up this or that candidate, and that they mean to support the party nomination. The candidate may be a man they would not trust with their private cash, or put at the head of any financial institution in which they had a stake, but at the bidding of party they will vote him into any public position, district, State, or Federal. The party caucus gives a consecration more potent than any holy oil, wiping out scars, tattoo-marks, and every species of blemish, and making the nominee "good enough" to represent the nation in the very highest seat of power. A vote so used is not treated as a public trust; it becomes merely the means of gratifying the selfish spirit of faction.

The principle we contend for is this: that the measure we mete to the rulers of the past, and to all sole depositaries of power, we should mete to ourselves. We have the power now in our own hands; the question is, What have we done with it—what are we doing with it? We know unfortunately that thousands and hundreds of thousands of voters would utterly spurn the idea of any responsibility attaching to their use of the suffrage. In this matter we can not be saved by any "remnant." If the majority go wrong here, the whole nation will go wrong; and its public policy may be determined to most lamentable issues. If it be asked what all this has to do with the scientific interests which this magazine is understood to advocate, we would answer, in the first place, that the function of science, in that broad sense in which we understand it, is to give a wise direction to the whole of human life; and, secondly, that the interests of science are intimately involved in the general condition of public opinion and public morality. Both of these considerations we shall continue to elucidate and enforce; meantime, we would press upon each individual citizen the consideration, which there is no evading, that the exercise of all political power and influence is a sacred trust, and that it is no less shameful a thing for the citizen of a free republic to give his vote under the influence of private motives *apart from the sense of public duty*, than it was for any of the despots of old to have made their larger powers mainly subservient to their own gratification.

A JEWISH EXPLANATION OF JEWISH SUCCESS.

One of the best contributions to the discussion of the Jewish question, that we have seen, is the article of Mr. Lucien Wolf, himself a Jew, in a recent number of the "Fortnightly Review." Mr. Wolf takes the ground that the chief reason why the Jews have been hated and persecuted is that they have possessed a form of religion and a system of morals and of self-government which have given them an advantage over all other races in the battle of life. Taking up an expression of Mr. Goldwin Smith's, he admits that Judaism is a system of "legalism"; but he goes on to say that "legalism" is what is wanted for this world—method, adaptation of means to ends, of effort to conditions, careful preservation of all that tends to superiority, and equally careful removal of all that makes for inferiority, whether physical, mental,

or moral. He admits that Judaism is materialistic in this sense, that it concerns itself exclusively with the present life, and he maintains that, just because it does so limit the scope of its calculations and efforts, do things, so far as this world is concerned, go well with it. "The substantial difference," he observes, "between Judaism and Christianity is, that the one desires to teach us how to live, the other how to die. Judaism discourses of the excellence of temporal pleasure, the divinity—if I may be permitted to use the expression—of length of days; Christianity, on the other hand, emphasizes the excellence of sorrow and the divinity of death. It is no wonder, then," he continues, "if, when competition arises between a race trained and hardened for worldly conflict and communities who have been taught to regard it as a duty to lay up their chief treasure in another world and to despise this, success should fall to the former rather than to the latter."

There is probably a measure of truth in these views. The Jews have, on the whole, been objected to because they have been too thrifty. The complaint has not been that they could not keep up with the pace of the rest of the world, but rather that they had a pace of their own, with which the rest of the world found it difficult to keep up. It is true also that a great bane, perhaps the chief bane, of the Christian world, has been a want of adaptation of means to ends, and a certain indisposition to take the laws of life—particularly its physical laws—seriously. Whence, if not from this cause, the huge pauper population with which Christendom has ever been burdened? Whence the failures of every kind with which the whole extent of society is strewn? There are people by the thousand who do not know a fact when they see it. There are thousands who dash themselves against the irresistible, or seek to flee the inevitable, instead of recognizing that what must be must be, and that the part of wisdom is to bow to inexorable law and seek to make with it the best terms possible. The world abounds with incapacity arising apparently from a kind of fateful wrongheadedness. We have thinkers who can not act, and actors who can not think, and people overflowing with sentiment who do more mischief with their good intentions than others with their bad. We have nothing to do with any of the theological implications of Mr. Wolf's article—which we need hardly say was not written with any theological purpose—but we incline to think that the main lesson which it contains is one which even those who would repudiate those implications most strongly might well consent to learn. That lesson we take to be this: that so much of "materialism" as consists in taking a clear view and firm grasp of facts, and in looking to facts rather than to fancies or sentiments for guidance, constitutes an important element of success in life, and should be so recognized in every scheme of education. To organize education, indeed, on any other basis, is but to invite failure, defeat, and misery. Whatever superiority may be assigned to the spiritual nature of man as contrasted with his physical part, the dependence of the former on the latter can hardly be questioned. When the bodily estate sinks into wretchedness, the moral character too often finds the same level. On every ground, therefore, we want a system of teaching that will help a man to help himself, thus providing at once for his physical comfort, his self-respect, and his intellectual and moral development. Mr. Spencer has said all this, as well as it can be said, in his treatise on education; and Mr. Lucien Wolf, following a very different path, and with very different objects in view, brings us again face to face with truths which we can not take too seriously to heart.

LITERARY NOTICES.

The Relations between Religion and Science. Eight Lectures preached before the University of Oxford in the Year 1884, on the Foundation of the late Rev. John Bampton, M. A., Canon of Salisbury, by the Right Rev. Lord Bishop of Exeter. New York: Macmillan & Co. Pp. 252. Price, $1.50.

It is now upward of a century since the Rev. John Bampton bequeathed his lands and estates to the authorities of Oxford University, the income of which was to be used forever in paying for a course of eight annual sermons or lectures devoted to the following objects: "To confirm and establish the Christian faith, and to confute all heretics and schismatics; upon the divine authority of the Holy Scriptures; upon the authority of the writings of the primitive fathers, as to the faith and practice of the primitive Church; upon the divinity of our Lord and Saviour Jesus Christ; upon the divinity of the Holy Ghost; upon the Articles of the Christian Faith, as comprehended in the Apostles' and Nicene Creeds."

If the well-intentioned founder of the celebrated Bampton Lectures could have foreseen what would be the result of a hundred years' experience in confirming the Christian faith and confuting heretics, according to the plan laid down, it is more than doubtful if he would have ventured upon the experiment. Had it been possible for him even to dream as to what sort of lectures his estate would pay for in one hundred and four years, he would have shrunk with horror from the awful result. For, although nothing more earnest or able or wise in defense of Christianity has been given by any of his predecessors than this last series of discussions by Dr. Temple, yet such has been the revolution of theological thought in a century that his book, if it had appeared in 1780, would have been execrated as the rankest conceivable infidelity. And yet, we repeat, no more skillful or powerful defense of fundamental Christian doctrine than these last Bampton Lectures has appeared in a long time. But the issues have been profoundly changed; and theological ground has been abandoned which a hundred years ago was regarded as the most essential part of the Christian faith.

There are of course plenty of living theologians who stick by the old—and the older the better—and with whom the intellectual progress of the last century goes for nothing. But among these the Bishop of Exeter does not belong. He is a liberal-minded, conscientious, and thoroughly trained thinker, who recognizes the tendencies and fully grasps the great results of modern scientific progress, which has opened a new world of truth to the human mind, and altered the point of view from which all the highest questions of human concernment are to be regarded. Instead of deploring the tendencies of advanced inquiry, and dreading the consequences of that deep and unwearying study of nature which characterizes our age, he regards it as something not to be reluctantly accepted, but to be welcomed and rejoiced in as the working out of a great providential dispensation. His lectures are characterized by this lofty and catholic spirit. They are widely contrasted in tone with that theological narrowness which has hitherto marked the controversial work of divines on the questions of the relations of religion and science.

We are here speaking of the temper and quality of Dr. Temple's work as a professed theologian, and not of the logical character of his argument. That will be regarded by many as in various points unsatisfactory. The work is highly instructive, and much important light is thrown on numerous points of controversy. But our chief interest in it is its striking significance in marking the progress of religious liberality. His attitude toward science is thoroughly untheological, using that term in its past and generally accepted sense. Dr. Temple professes his belief in miracles, but he declares that "Science can never, in its character of Science, admit that a miracle has happened." But he holds that all alleged miracles, on some possibly higher view yet to be reached, may disappear as miracles, and be shown conformed to a more enlarged view of the natural order. We may say generally that the force of his reasoning is derived from the present limitations and incompleteness of scientific truth.

It is especially noteworthy that the Lord Bishop of Exeter broadly accepts the doctrine of evolution. But it is not enough to

say that he merely accepts it. He maintains that it is not irreligious, that it is not hostile to Christianity; but, on the contrary, is the highest and noblest view of the universe, that it exalts the Divine character, and is, in fact, a great revelation, which among its many grand effects must exert an elevating and ennobling influence upon religious thought. We print a portion of the bishop's argument, which bears upon this question, in the present number of the "Monthly."

Cottages; or, Hints on Economical Building. Compiled and edited by A. W. Brunner, Architect. New York: William T. Comstock. Pp. 54, with Twenty-three Plates.

The plans given in this book are intended to respond to a change which the author conceives to have come within the past few years over our conception of what a country home should be. "Simplicity, elegance, and refinement of design are demanded, and outward display, overloading with cheap ornamentation, is no longer in favor. . . . Now that English gables and dormers have spread so widely; now that we realize the beauty of our own colonial architecture, and that the Queen Anne craze is subsiding so that only its best features remain, the less ambitious dwellings must not be left to the mercy of those builders whose ideas of beauty are limited to scroll-saw brackets and French roofs." The designs are presented to show what can be done with modest means, and have been contributed by different New York architects. They are accompanied by a descriptive letterpress giving practical suggestions for cottage building, and are supplemented by a chapter on heating, ventilation, drainage, etc., by William Paul Gerhard.

Commentaries on Law. By Francis Wharton, LL. D. Philadelphia: Kay & Brother. Pp. 856.

Dr. Wharton, member of the Institute of International Law, is known as the author of several works on jurisprudence which have attained a high repute in the legal profession. The present treatise is a kind of introduction to the general subject of law and its authority, and embraces chapters on "The Nature, the Source, and the History of Law; on International Law, Public and Private; and on Constitutional and Statutory Law." It might be as well, while we are revising our courses of school and college instruction, to make some provision for teaching the people what law really is, and upon what it rests; for there seems to be nothing on which their minds are more at sea, and on which American citizens are more in need of sound instruction. Those who believe that it is anything that Legislatures may enact and interested parties try to evade—and there are apparently many such—will find new light shed upon the subject by the perusal of Dr. Wharton's book. Here the principle is asserted, and illustrated in discussion and citations, that "law as a rule of action is the product of the nation by which it is adopted," the nation not acting intermittingly and at particular times, but developing its statutes in the regular course of its life. "The laws which are really operative, and of which all efficient and enduring statutes are merely declaratory, are emanations rather than efforts; are the products and not the molders of custom; are the instinctive and unconscious outgrowth of the nation, and not the creatures either of *a priori* political speculation or of arbitrary sovereign decree"; and that not only must law both precede and define sovereignty, but "no law imposed by a sovereign can be permanently operative, unless it is declaratory of existing conditions."

Diseases of the Throat and Nose. By Morell Mackenzie, M. D. Vol. II. Philadelphia: P. Blakiston, Son & Co. Pp. 550. Price, $4.

Aside from the scientific value of its discussions and the adequacy of treatment, there is one feature of this book that deserves unalloyed commendation. "It is now twelve years," says the author, "since this work was commenced, and during that period there is scarcely a page that has not been written and rewritten several times." The treatise is intended to include affections of the pharynx, larynx, trachea, œsophagus, nose, and naso-pharynx. The present volume embraces diseases of the œsophagus, nose, and naso-pharynx, with an index of authors and formulas for topical remedies. Each kind of affection is taken up separately, and subjected to a full treatment in all

of its aspects. The author has had an "unrivaled experience" of twenty years' practice in the class of diseases of which he treats; and this, with the conscientious labor he confesses to have put upon it, seems to be all that should be needed to certify it a work of most eminent merit and value.

An Outline of the Future Religion of the World. With a Consideration of the Facts and Doctrines on which it will probably be based. By T. Lloyd Stanley. New York: G. P. Putnam's Sons. Pp. 588. Price, $3.

The author assumes that theological criticism having demonstrated the unsound foundations of many of the hitherto received dogmatic beliefs, it is in place to indicate a philosophically sound basis for religious trust in the future. The Hebrew, Vedic, Zoroastrian and Buddhist religious systems are reviewed, in a spirit friendly to all; the Christian system is considered at greater length, as superior to them all, and the conclusion arrived at that the world's religion of the future is destined "to rest mainly on the teaching of Christ, as that teaching becomes separated by criticism from the additions made to it by his disciples and by the early Church, and more fully expounded and understood. The Great Unity, the Unity of Life, physical and spiritual, will be recognized as a prominent feature of the Master's teaching. But the Christianity of the future will be relieved from the incubus of the marvelous and the legendary." This Principle of Life—"that all lives form part of one endlessly progressive Universal Life, culminating in Supreme Mind"—is asserted to be the essential truth of religion, "whose law is declared by the voice of conscience in each heart," and has been expounded as altruism.

Mineral Resources of the United States. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 813.

This is one of the reports of the United States Geological Survey. The statistical department contains a section devoted to each of the economical minerals of the country, of length and fullness proportioned to the importance of the mineral and the magnitude of its commercial production. This is followed by special papers on "The Diving Rod," by R. W. Raymond; "Electrolysis in the Metallurgy of Copper, Lead, Zinc, and other Metals," by C. O. Mailloux"; "The Minor Minerals of North Carolina," by W. C. Kerr"; "Minor Minerals of the Pacific Coast"; and a table of localities of the useful minerals of the United States.

Education by Doing. By Anna Johnson. New York: E. L. Kellogg & Co. Pp. 109.

The author of this manual is a teacher in the Children's Aid Society schools of this city. Believing that Froebel's discovery of education by occupation is capable of being extended to the public school and adapted to a later age, she has endeavored to show some of the ways and suggest others in which the children may be kept pleasantly and profitably employed. We have in the course exercises with blocks, beans, cards, pins, shoe-pegs, etc., to teach number; similar exercises with appropriate tools to teach weights and measures, form and geography, and color and form; exercises with pictures and cards to teach language; "busy work" to teach reading, writing, spelling, and correct speech; and miscellaneous exercises and "slate-work."

Life and Labor in the Far, Far West. Notes of a Tour in the Western States, British Columbia, Manitoba, and the Northwest Territory. By W. Henry Barneby. London and New York: Cassell & Co. Pp. 432. Price, $2.

Mr. Barneby is a young Englishman, with not much experience in literary work, but a good traveler. With two companions he traveled in 1883 through the regions named, saw much that was new to him, though it might not all be new to older travelers, and enjoyed his trip. He made regular notes of what he saw and sent them to his wife, who set them down in a book. The value of the sketches lies in the unaffected accuracy with which the author's off-hand impressions are recorded. Some suggestive glimpses are given of conditions of frontier life that are being pushed farther and farther away from the States. There is, for instance, the British Columbian justice, who, when he had to preserve order at Cariboo during the gold-fever, did it so well that he was said to spend his leisure hours on

Sunday looking out for trees on which to hang criminals on Monday; and there is a story of a photographer in Washington Territory "taking views" of the lynchers hanging some men, and "making quite a pile" by the sale of copies. The descriptions of country and scenery are terse and definite, and something may be gathered from the narrative concerning the economical value of the various districts to which it relates.

Correspondences of the Bible. The Animals. By John Worcester. Boston: Massachusetts New Church Union. Pp. 294.

In the view of the author of this book, "the natural objects of the world about us are images, or manifestations to bodily sense, of the spiritual things in human minds. . . . Every branch of science, with all the particulars of it, is a physical emblem of deeper things than itself; and, if interiorly opened, it presents to our view a corresponding branch of spiritual science, with its particulars . . . Common speech testifies to a general recognition of relationship between animals and human feelings"—as when we emblematically use the names of different animals in describing various human qualities. The traits and peculiarities of all the animals named in the Bible are considered under this aspect.

Geology and Mineral Resources of the James River Valley, Virginia. By J. L. Campbell, LL. D. New York: G. P. Putnam's Sons. Pp. 119, with Map and Geological Sections.

The object of the author of this report is to lay before the minds of capitalists, immigrants, his fellow-citizens, and others who are interested in Virginia, "a concise yet comprehensive statement of the great extent and variety of available resources within the area under review, which only await capital, enterprise, and labor, to make them productive." The report reveals a great wealth in iron-ores, limestones, and forest products, with manganese, gold, slates, granite, steatite, mica, kaolin, barytes, white-sand, and asbestus, which are doubtless destined to have a large development in the future, and which are brought within reach of the market by means of the Richmond and Alleghany Railroad.

Arithmetical Aids. Boston: Houghton, Mifflin & Co. In box.

The "Aids" consist of single counters and strips of ten counters each, and of cards expressing quantities of goods supposed to be sold, and values. The counters are used in solving problems in the four arithmetical rules; the goods-cards furnish stock to the pupil, who is supposed to keep a store; and the value-cards represent money in the hands of the supposed buyer of the goods. By a judicious use of the two kinds of cards, with the addition of such other goods-cards as it may suit the players to devise, all the transactions of store-keeping can be performed. Thus exercises in the learning of business, as well as amusement, may be had out of the Aids. A tract packed in the box explains the use of the Aids, and gives suggestions of other "arithmetical diversions."

A Grammar of the German Language. For High-Schools and Colleges. By H. C. G. Brandt. New York: G. P. Putnam's Sons. Pp. 278. Price, $1.50.

This grammar, which is designed both for beginners and advanced students, embodies the results of philological research during the last twenty years, so far as it concerns the German language, and draws from the works of eminent modern writers on the subject. From the brief examination we have been able to give it, it strikes us as a systematic and well-matured work, that can not fail to be useful to those who wish to study the language critically.

A Reader of German Literature. Prepared, with Notes, by W. H. Rosenstengel. New York: G. P. Putnam's Sons. Pp. 402. Price, $1.50.

The Reader is intended for students who have mastered a German grammar and an elementary reader, and are at home in using the dictionary. It aims to confine the selections to masterpieces; to give a full representation to modern literature; to add selections from the best and latest works on German history and the history of the civilization and language of the country; and to set forth accurate texts. Biographical sketches are given of some of the authors, and analyses of the more important works quoted from; and a chronology of German literature is added.

Tableaux de la Révolution Française (Pictures of the French Revolution). Edited, with Notes, by T. F. Crane and S. J. Brun. New York: G. P. Putnam's Sons. Pp. 311. Price, $1.50.

The object of this volume is to furnish the student with French reading of not a difficult nature, and at the same time to give some insight into the great historical epoch to which it relates. It does not give a continuous history of the Revolution, but a series of sketches, the gaps between which can easily be filled up, and it closes with the end of the Reign of Terror. We are surprised not to find the name of Lamartine among the authors quoted from.

Elements of Analytic Geometry. By Simon Newcomb. New York: Henry Holt & Co. Pp. 356. Price, $1.50.

Professor Newcomb has endeavored to arrange this work so that it shall be adapted both to those who do and to those who do not wish to make a special study of advanced mathematics. Beginning with a summary of the new ideas associated with the use of algebraic language, which the student is to encounter, it gives the usual college course in plane analytic geometry; a part on geometry of three dimensions; and an introduction to the modern projective geometry.

Report of the Board of Regents of the Smithsonian Institution for 1882. Pp. 855. Washington: Government Printing-Office. 1884.

This volume contains reports of the Executive Committee of the Board of Regents and of the Secretary of the Institution, the latter being an extended summary of the work done during the year by the various scientific departments connected with the Institution. It contains also a "Record of Recent Scientific Progress," and numerous anthropological papers, some of which are illustrated, nearly all describing excavations in ancient American mounds.

PUBLICATIONS RECEIVED.

Mental Contagion in Inebriety. By T. D. Crothers, M. D., Hartford, Conn. Pp. 9.

Public Relief and Private Charity. By Josephine Shaw Lowell. New York: G. P. Putnam's Sons. Pp. 111. 40 cents.

Religious Unrest. By M. J. Savage. Boston: George H. Ellis. Pp. 14.

The Late Attacks upon the Coast and Geodetic Survey. Philadelphia: L. R. Hamersley & Co. Pp. 52.

International Health Exhibition. Catalogue of Exhibits of the Department of Education, Empire of Japan. Pp. 30. General Outlines of Education in Japan. Pp. 29. London: William Clowes & Co.

The Ellipticon. By J. L. Naish. New York: John Wiley & Sons. Two-page Chart.

"The Canadian Record of Science." Vol. I, No. 1, Quarterly. Montreal: Dawson Brothers. Pp. 64. $3 for eight numbers.

A Sketch of the Geology of Philadelphia and its Surroundings. By Professor Angelo Heilprin. Pp. 6, with Map.

A Contribution to the Study of Coryza Vasomotoria Periodica, or "Hay-Fever." By John N. Mackenzie, M. D. Pp. 16.

Notes on Injurious Insects. From the Entomological Laboratory of the Michigan Agricultural College. Pp. 31.

Transactions of the Medical and Chirurgical Faculty of the State of Maryland. Baltimore, April, 1884. G. Lane Taneyhill, Secretary. Pp. 248.

Protection and Communism. By William Rathbone. New York: G. P. Putnam's Sons. Pp. 42. 10 cents.

Home School for Physical Culture. D. L. Dowd, 19 East Fourteenth Street, New York. Pp. 24.

Microscopic Observations on Internal Parasites in Fowls and on Butter and Fats. By Thomas Taylor, M. D. Washington: Department of Agriculture. Pp. 7.

Sponge Spicules; A Supposed New Species of Cristatella. By Edward Potts, Philadelphia. Pp. 12, with Plate.

The Azoic System and its Proposed Subdivisions. By J. D. Whitney and M. E. Wadsworth, Cambridge Museum of Comparative Zoölogy. Pp. 260.

National Educational Association, Department of Superintendence, February, 1884. Washington: Government Printing-Office. Pp. 176.

Bureau of Statistics, Treasury Department, Quarterly Report to June 30, 1884. Washington: Government Printing-Office. Pp. 160.

The Effect of Wind-Currents on Rainfall. By G. E. Curtis, Signal Corps, U. S. Army. Washington: Signal-Office. Pp. 11.

Finley's Tornado Predictions. By G. K. Gilbert. Detroit, Mich.: W. H. Burr & Co. Pp. 8.

The Miner's Fund of New Almaden. By Samuel B. Christy, Berkeley, Cal. Pp. 8.

American Society of Civil Engineers. Address of President J. D. Whittemore. Pp. 13.

How to Study. By Professor S. T. Skidmore, Philadelphia. Pp. 16.

Suggestions for computing the Speed of Chemical Reactions. By Robert B. Warder, North Bend, Ohio. Pp. 4.

Emblematic Mounds. By Stephen D. Peet. Pp. 68.

Sex in Mind and in Education. By Henry Maudsley, M. D. Syracuse, N. Y.: C. W. Bardeen. Pp. 36. 10 cents.

Bulletin of the Bussey Institution, Harvard University. Boston: John Allyn. Pp. 120. 75 cents.

Papers on American Grasses. By Dr. George Vasey and Clifford Richardson. Washington: U. S. Department of Agriculture. Pp. 144, with 120 Plates.

Ottawa Field Naturalists' Club. Transactions, No. 5. Ottawa, Can.: Citizen Printing and Publishing Company. Pp. 152.

Catalogue of North American Hepaticæ. By Lucien M. Underwood. Peoria, Ill.: J. W. Franks & Sons. Pp. 133.

The Human Body, and how to take Care of it. By James Johonnot and Eugene Bouton. New York: D. Appleton & Co. Pp. 162. 50 cents.

Book of Cats and Dogs and other Friends. By James Johonnot. New York: D. Appleton & Co. Pp. 96 20 cents.

A Compend of Geology. By Joseph Le Conte. New York: D. Appleton & Co. Pp. 399. $1.50.

Forestry of the Ural Mountains. Compiled by John Croumbie Brown. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 182.

Occult Science in India and among the Ancients. By Louis Jacolliot. New York: John W. Lovell & Co. Pp. 275.

Icaria: A Chapter in the History of Communism. By Albert Shaw, Ph. D. New York: G. P. Putnam's Sons. Pp. 219. $1.

My Farm at Edgewood. By the author of "Reveries of a Bachelor." New York: Charles Scribner's Sons. Pp. 339. $1.25.

Country Cousins. By Ernest Ingersoll. New York: Harper & Brothers. Pp. 252.

U. S. Life-Saving Service. Report for 1883. Washington: Government Printing-Office. Pp. 519.

There was once a Man. By R. H. Newell. New York: Fords, Howard & Hulbert. Pp. 526. $1.50.

An Appeal to Cæsar. By Albion W. Tourgee. New York: Fords, Howard & Hulbert. Pp. 422. $1.

Black and White. By T. Thomas Fortune. New York: Fords, Howard & Hulbert. Pp. 310. $1.

The Physician's Visiting List for 1885. Philadelphia: P. Blakiston, Son & Co.

The Northern Sugar Industry during the Season of 1883. By H. W. Wiley Pp. 120, with 11 Charts. Composition of American Wheat and Corn. Second report by Clifford Richardson. Pp. 98. Washington: Department of Agriculture, Bureau of Chemistry.

Popular Fallacies regarding Precious-Metal Ore-Deposits. By Albert Williams, Jr. Pp. 16.

Comprehensive Anatomy, Physiology, and Hygiene. By John C. Cutter, M.D. Philadelphia: J. B. Lippincott & Co. Pp. 376. $1.

The Eclectic Physiology. By Eli F. Brown, M.D. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 189.

A Thousand Questions on American History. Syracuse, N. Y.: C. W. Bardeen. Pp. 247.

Bread-Making. By T. N. T. New York: G. P. Putnam's Sons. Pp. 64. 50 cents.

The Lock-Jaw of Infants. By J. F. Hartigan, M. D. New York: Bermingham & Co. Pp. 123.

Outlines of Roman Law. By William C. Morey, Ph. D. New York: G. P. Putnam's Sons. Pp. 433. $1.75.

Report of the Commissioner of Education. 1882–'83. Washington: Government Printing-Office. Pp. 872.

Magneto- and Dynamo-Electric Machines. By Dr. H. Schellen. New York: D. Van Nostrand. Pp. 518.

Our Birds and their Haunts. By the Rev. J. Hibbert Langille. Boston: S. E. Cassino & Co. Pp. 624.

A Migration Legend of the Creek Indians. By Albert S. Gatschet. Vol. I. Philadelphia: D. G. Brinton. Pp. 251.

A System of Psychology. By Daniel Greenleaf Thompson. London: Longmans, Green & Co. Two vols. Pp. 613 and 589. 36s.

The Destiny of Man viewed in the Light of his Origin. By John Fisk. Boston: Houghton, Mifflin & Co. 1884. Pp. 121. $1.

Thomas Carlyle: A History of his Life in London, 1834–1881. By James Anthony Froude, M. A. New York: Charles Scribner's Sons. 1884. Pp. 417. $1.50.

POPULAR MISCELLANY.

American Association Addresses.—Professor J. W. Langley's vice-presidential address before the Chemical Section of the American Association was on "Chemical Affinity." He opened his paper with a review of the various theories that had been proposed to account for chemical action from Hippocrates down, and showed how the term "affinity" has disappeared from the chemical literature of the present day. Three methods of studying the force of affinity have been taken up and followed in parallel courses, which may be designated as the thermal, the electrical, and the method of time or speed. It is deduced from thermo-chemical phenomena that the work of chemical combination is largely influenced by the surrounding conditions of temperature, pressure, and volume, and that the force of affinity is dependent on the conditions exterior to the reacting system which limit the possible amount of change. The electrical method has been followed less actively than the thermal one, and has not led to any particularly definite results. Very little work has been done in the method of time or speed of chemical reaction, in which, however, Professor Langley suggests that the future of chemical research may lie. Chemistry is behind physics, in that it is served by only two fundamental conceptions—mass and volume—while physics is underlain by three—space, mass, time. What would physics be without the notation of velocities? such in a measure is chemistry without taking account of dynamics. Whenever we look outside of chemistry, we find that the lines of the great theories along which progress is making are those of dynamic hypotheses. So it is in biology, in geology, and in physiology, where all observations are made in the light of time-indications; and so it must be in chemistry. "The study of the speed of reaction has but just begun. It is a line of work surrounded with unusual difficulties, but it contains a rich store of promise."

In his address before the Geological and Geographical Section on "The Crystalline Rocks of the Northwest," Professor N. H. Winchell presented some considerations in favor of recognizing and adopting in Ameri-

can geology the Taconic group which was set forth by Dr. Emmons in 1842. Until very recently it has been the practice of geologists to refer every crystalline rock in the Northwest—in Michigan, Wisconsin, and later in Minnesota—to either the Huronian or Laurentian system. A more careful examination has shown that the nomenclature is imperfect, and needs to be amended or supplemented. Omitting the igneous rocks of dikes and overflows, the crystalline rocks underlying the shales and sandstones of the cupriferous formation in the Northwest may be arranged, in descending order, in six groups. The first group consists of granite and gneiss with gabbro, and has been variously regarded by different geologists. Below this is a series of strata that may be designated by the general term *mica-schist group*. Next is a group of black mica-schists, with carbonaceous and arenaceous black shales, under which is a very thick series of obscure hydromicaceous and greenish magnesian schists, with beds of gray quartzite and clay slates and deposits of hematite iron-ore, terminating with magnetic iron-ore. The fifth group consists of gray quartzite and marble, and rests upon the lowest recognized horizon of granite and syenite, with hornblendic schists. Difficulties rise when it is attempted to find correspondences between these groups and any of the now recognized Eastern formations. Dr. Emmons erred in his first presentation of the Taconic system by extending it geographically too far east, and choosing a name for it which is appropriate only to a part of that eastward extension, and for that reason, perhaps, among others, it has fallen out of favor. In Professor Winchell's view, however, his claim, "in all its essential points, remains intact." This consists in the existence of a series of sedimentary deposits, largely metamorphic, below the Potsdam sandstone, and separating the Potsdam from the crystalline rocks known as "primary" in an orderly chronological sequence. His system, going from the top down, comprised a black slate, including a considerable amount of carbonaceous matter; an argillaceous, siliceous, and "talcose" *Taconic slate;* the "Stockbridge limestone"; graduating downward into "talcose" or magnesian sandstones and slates; a "granular quartz-rock," with slates and becoming in some places a conglomerate with a "chloritic paste"; and the "ancient gneiss" on which the formation rested unconformably. In this several correspondences are found with the definitions of the crystalline rocks of the Northwest. Professor Winchell concludes that Dr. Emmons's Taconic included three of the six groups of the Northwest; that the Huronian of Canada is the equivalent of the lowest of the Taconic groups, and the perfect parallel of only the lowest of the groups in the Northwest that have been designated Huronian; that the uppermost of the groups in the Northwest is local in its existence and exceptional in its characters, and has therefore received a variety of names; and that there are, therefore, confusion and conflict of authority in the application of names to the crystalline rocks of the Northwest.

Professor Cope chose, as the subject of his address before the Biological Section, catagenesis, or the doctrine of the process of creation by the retrograde metamorphosis of energy, or by the specialization of energy. He began his argument by assuming that the general proposition that life has preceded organization in the order of time may be regarded as established; for it follows necessarily from the fact that the simple forms have as a rule preceded the complex in the order of appearance on the earth. Consciousness is coeval with life and has preceded all action, even such actions, called automatic and reflex, as are now performed in incomplete or complete unconsciousness. They were performed for the first time consciously and of design, but by frequent repetition they became habitual, and consciousness finally disappeared. Life, then, may be defined as energy directed by sensibility, or by a mechanism which has originated under the direction of sensibility. Consciousness is a property of matter, although clearly not of all kinds of matter. It is, then, of course subject to the laws of necessity to which matter and energy conform. The key to many weighty and mysterious phenomena of animal life can be found in the fact that energy can be conscious; but, when energy has become automatic, it is no longer conscious, or is about to become unconscious. In animals, with the development of habit,

energy, on the loss of consciousness, undergoes a retrograde metamorphosis, as it does later in the history of organized beings on their death. This loss of consciousness is first succeeded by the so-called involuntary and automatic functions of animals. According to the law of catagenesis, the vegetative and other vital functions of animals and plants are a later product of the retrograde metamorphosis of energy. Yet the conscious animal kingdom is dependent on the unconscious vegetative, and the living vegetative on the dead inorganic kingdom, for nutrition, and consequently for existence. So the animal organism could not have existed prior to the vegetable nor the vegetable to the mineral. The explanation of this paradox is found in the wide application of the "doctrine of the unspecialized," in the light of which creation consists in specialization, or in the specific action of Spencer's general principle of the conversion of the homogeneous into the heterogeneous. The material basis of consciousness must, then, be a generalized substance which does not display the more automatic and the polar forms of energy, and is found in protoplasm. This is manufactured by living plants out of inorganic matter. For the first production of it, the generative energy must have previously existed in some form of matter not protoplasm, the detection of which must be left to future research. Both vegetable and animal kingdoms have been derived from the simplest of beings, some of whose forms may be still among us. The vegetable kingdom consists of organisms which consciousness has abandoned, and which have become automatic, sessile, parasitic, more automatic and degenerate. "The animal line may have originated in this wise: some individual protists, perhaps accidentally, devoured some of their fellows. The easy nutrition which ensued was probably pleasurable, and once enjoyed was repeated, and soon became a habit. The excess of energy thus saved from the laborious process of making protoplasm was available as the vehicle of an extended consciousness. From that day to this, consciousness has abandoned few if any members of the animal kingdom. In many of them it has specialized into more or less mind." If the principles here adopted be true, it is highly probable that all forms of energy have originated in the process of running down or specialization from the primitive energy.

Professor Edward S. Morse, Vice-President of the Anthropological Section, made the existence of "Man in the Tertiaries" the subject of his address. He began by predicating that rational investigation of man's origin had been obstructed by self-created barriers, which had to be ascended and overthrown one after the other. One of these barriers, which was interwoven with theological dogma, was removed some time ago. The next barrier was the one erected by Cuvier, in the idea that man, being highest in development of the animals, must have been latest in origin, and therefore could not have been contemporary with any but present fauna. This was overthrown by the discovery of relics of quaternary man. The discovery of evidences of human existence in tertiary formations has also been discredited by Gaudry and Dawkins, because no species now extant existed then; and Dawkins adds that, if man had been living then, he must have been subjected since to changes commensurate with those which other animals have undergone. The idea has also prevailed that man has been evolved from the higher apes, and that his nearest relatives among those creatures are those which are supposed to have appeared last in the sequence. Evidences of man are, however, found associated with extinct apes, and the gap between the two organisms is by no means closed. The apes are distinctly apes, and the man, though with ape-like features, is still man. The first anthropoid ape appears to have been found in the Middle Eocene, and later still a more generalized form, Oreopithecus, having affinities with anthropoid apes, macaques, and baboons. Side by side with them are to be found chipped flints. The approach of the two groups, man and apes, which seem to have co-existed here, must be sought far back. Man must have existed long before he could have left any marks of his work, "for before the rudest flint was fashioned by him he must have used natural fragments of sticks and stones, and even this faculty must have indicated an advance far beyond that of his progenitors, who had not acquired even

the habit of handling weapons—the earliest evidences of man must be sought for in his remains, and not in his works," and here we meet difficulties, for the remains of man, being generally left in situations where they are exposed to decay, disturbance, or removal, are rarely found, even where the remnants of his works are numerous, as in the shell-mounds, caves, and lake villages. Hence, discovery of the remains of primitive man is highly improbable. That man has not changed in his physical characteristics in the same proportion as other animals is explainable by considering that the moment the ancestors of man possessed the power of banding together in communities, and of using weapons, they became capable of rendering inoperative the very influences which were so active in modifying or exterminating their mammalian associates. Cope has shown that the formation of man's feet is more like that of the earlier plantigrade type than that of the later ungulate and carnivorous types, in which the heel is lifted up. Man's structural relations are not only with the higher forms of apes, but also with those of the whole range from the gorilla down, and osteologically even with the half-apes and the lemuroids, which last have been discovered in the Lower Eocene of both continents. If these structural affinities are established, we must look far beyond and below the present higher apes for the diverging branches of man's ancestry. Another evidence of high antiquity is afforded by the wide dispersion of the points at which the remains of early man have been found. It must have taken an enormous period for a race so low in savagery to have acquired so extensive a range.

General John Eaton, Vice-President of the Section of Economic Science and Statistics, spoke on the value of "Scientific Methods and Scientific Knowledge in Common Affairs." There is no good reason, he said, why scientific men should neglect to apply scientific methods to the economy and statistics of every-day life. It is unfortunate that scientific men aspire so exclusively to original research. We need men to couple love of science with love of mankind. Is not benefit to mankind the real measure of the good that is in science? The scientific method of communicating truth recognizes the fact that man's powers are shaped, and too often the bulk of his knowledge is acquired, in early life. Hence its fundamental rule must be simplicity in the use of language, and in the presentation of each truth in the concrete. Adopted in the whole domain of scholastic instruction, it would bring new votaries to science, and a better taste for all kinds of literature would result. The progress of the race is tending toward a gathering up, for man's daily use, of all the lessons of Nature, and to their application for the prevention of disorders and the anticipation of the need of measures for cure. As balance-sheets are studied in business, so are questions of finance, of taxation, and public expenditure. Great operations demand and have their collections of statistics and their vast accumulations ready as communications to economic science. But the correlation of all these and their actual results have not yet been reached. Nevertheless, money sees the profits of this wisdom, and is more ready to pay for it.

The French Association.—The thirteenth meeting of the French Association for the Advancement of the Sciences was opened at Blois, September 3d. The capital fund of the Association was reported to amount to $100,000, and $1,500 had been applied to scientific researches. The President, M. Bouquet de la Grye, made the opening address, on the subject of the "Progress of Hydrography in France." He suggested that variations in the level of the sea might exist in consequence of differences in the saltness of the water producing variations in density, and of differences in temperature. The level of the Mediterranean should be lower than that of the ocean, because its water is more dense. An increase of temperature in the German Ocean would flood the coasts, and make Paris a seaport. Dr. Grimaux delivered a memorial address on the academicians who had died during the year. Mr. Bouley presented a paper on M. Pasteur's recent investigations. The Marquis de Rochambeau spoke on the archæological treasures of the Vendôme. A formal visitation was made by the members of the Association as a body to the statue of Denis Papin, who was a native of Blois, and

a wreath was placed at its feet. M. Tresca made the memorial address, and claimed for Papin the distinction of having been the inventor of the first steam-engine. Excursions were made to various places of interest, among them the strata of Thenay, where Abbé Bourgeois thinks he has discovered relics of tertiary man, and the Celtic caverns of Troô.

Discussions at the Electrical Conference.—An Electrical Conference sat in Philadelphia, in connection with the Electrical Exhibition, during the second week in September, and was attended by about one hundred and seventy-five American and foreign delegates. Professor Simon Newcomb opened the session with an address of welcome, after which the President of the Conference, Professor Henry A. Rowland, presented in his official address the subjects of the interdependence of applied and pure science, some of the questions still open in electrical science, and the need of more careful training in the theory of electricity in technical schools. The meetings of the Conference were continued, with discussions of the best methods of extending our knowledge of atmospheric electricity and earth-currents, and any possible relation that may exist between them and the weather, by Professor Abbe; the question of the establishment of a Bureau of Physical Standards, under the supervision of the Government, by Professor Snyder and other members of the Conference; the theory of the dynamo-electric machine, by Professor Rowland, with remarks by Professor Fitzgerald, of Dublin, and Professor Silvanus P. Thompson; the electrical transmission of energy, by Professor Nipher, of Washington University, St. Louis; storage-batteries, by Mr. W. H. Preece and Professor Dewar; and long-distance telephony. On the last subject Mr. T. D. Lockwood mentioned earth-currents, atmospheric electricity, imperfect contacts, and leakage from other lines, together with electro-static and electro-dynamic induction, as causes of the noises on telephone lines. Long lines are more subject to these troubles than short ones, and north and south lines than east and west ones. Sometimes one end of the line will be noisy and the other end quiet, as between Chicago and Milwaukee, where it is quiet at the Chicago end and noisy at Milwaukee. Lines subject to nearly uniform leakage are more quiet than well-insulated lines, lines near the sea than inland ones, and lines of small wire than lines of large wire. Many of the sources of disturbance may be got rid of by providing a metallic return-circuit, hung parallel to the first circuit and similarly to it. When a long air-line ends in a short underground cable, the person at the end of the cable can make himself heard, while the person at the end of the long line can not. Captain O. E. Michaelis recommended the study of iron, copper, brass, etc.—the metals used in structures—by electrical or magnetic methods—with a view to finding means of discovering defects and weaknesses. On the electrical protection of houses, Professor Rowland spoke well of the conductors enveloping the house as if they were a cage: thus, it is well to have the rods run down the four corners of the house and across the angles of the roof, joining at the top, so as to form the skeleton of the cage. Additional rods may also be run down the sides of the house. The rods must be well grounded, otherwise they will be worse than useless. Twisted rods are not recommended. Small rods, bearing points, should rise from the main rods at different points on the roof.

The Association of Official Chemists.—An Association of Official Chemists of the United States was organized during the meeting of the American Association. Chemists of the Department of Agriculture, State agricultural societies, and boards of official control, are eligible to membership in the Association, and each of the organizations thus represented is entitled to one vote on all matters on which the society may ballot, while other chemists are invited to attend the meetings and take part in the discussions, without having the right to vote. Three standing committees were appointed —on the determination of phosphoric acid, nitrogen, and potash—who will distribute samples for comparative work, and report the results at the annual or at special meetings. The following officers of the Association were elected: President, Professor S. W. Johnson, of Connecticut; Vice-President, Professor H. C. White, of Georgia;

Secretary and Treasurer, Dr. C. W. Dabney, Jr., of North Carolina. Dr. E. H. Jenkins, of Connecticut, and Dr. H. W. Wiley, of Washington, were constituted the Executive Committee. The annual meeting of the Association is to be held on the first Tuesday in September.

The Esquimaux and the Cave-Men.—Professor Boyd Dawkins presented before the British Association the considerations in favor of his theory that the Esquimaux are the survivors of the prehistoric "cave-dwellers." Everywhere the Esquimaux are found, he said, along the Arctic coasts of Greenland and America, and into Asia, they are a receding race. Mr. Dall has shown that they formerly dwelt on the west coast of America far south of their present abode, and the speaker has found evidence of their former presence south of their habitat in Asia. They present the appearance of being a distinct race. To find other men like them we have to go back to geologic times, to the cave-men, with whom they show several points of resemblance. Both dressed in skins and wore long gloves, were hunters and fishermen, showed considerable artistic taste and skill, and used implements of stone and bone. The Esquimaux do not bury their dead, and there are many reasons for believing that the cave-men did not. Other speakers questioned the force of Professor Dawkins's arguments. They held that the human remains found with the cave-dwellers' relics, which Professor Dawkins regarded as intrusive, were genuine, and that they represented a different physical structure from that of the Esquimaux; that other traits, insisted upon as common, were not peculiar to these two peoples alone; and that the reason the Esquimaux do not bury their dead is simply because the conditions of the climate do not often allow it. Lieutenant P. H. Ray gave reasons for believing that the Esquimaux had occupied the far north of America from a remote period. Snow-goggles, like those now in use, have been dug up twenty-eight feet below the surface of the ground. Mr. Ray believed the Esquimaux to be a people of the ice, living from extreme antiquity along the ice-border, and following it as it advanced or receded. He considered them distinct from the Indians in physical traits and in character, as well as in language. They were naturally a peaceful people, very superstitious, but without a distinct religion, and without the conception of a future existence. They did not bury their dead because the climate rendered it usually impossible, but merely conveyed the corpse to a distance from the village, and left it to be devoured by the dogs. That, they said, was the end of man. But they had ideas about a superior Being, who had created men and animals, and believed in an evil spirit.

NOTES.

From papers read in the British Association, it appears that the most important coal-fields in the Acadian or St. Lawrence basin are those of Cumberland, Pictou, and Cape Breton. The other coal-regions of the Dominion are one extending from the ninety-seventh parallel to the base of the Rocky Mountains, and one on Vancouver's Island. Of the three fields, the first is in the carboniferous, while the other two belong to the secondary or tertiary formations.

M. V. Magniant writes to the "Revue Scientifique" that he has a cat which shows signs of intelligent reflection. Not only does it look behind the mirror for the cat which it sees reflected in the glass, but it has been caught several times attentively regarding a sculptured cat's head that hangs on the wall. It would get upon the back of a chair, and then stand up and stretch out its paw to touch the image of itself. It has outgrown the sports of kittenhood, but when it is asked in the morning if it is hungry it emits two sounds, that clearly mean yes, with an articulation that is never heard under any other circumstances. It loves flowers, not eating them, but inhaling their perfume with a visible satisfaction.

Mining-Engineer Wenzel Poech, of Austria, has discovered a simple, cheap, and practicable means of preserving mineral coal from deterioration in the open air, where it is liable to crumbling, and oftentimes to spontaneous combustion. It consists principally in treating the coal-pile with steam for the exclusion of the air, and securing a permanent retention of moisture by the coal. The theory of the process is that the deterioration of coal is caused by its absorption of oxygen and other gases, for which the way is opened by the evaporation of the hygroscopic moisture. If the coal is kept full of water, this can not happen.

Professor Archibald stated, in the British Association, that the "Krakatoa committee" had succeeded in collecting much

information concerning the red sunsets and the diffusion of volcanic dust, which had not yet been examined; and he could only say that nothing had yet appeared which was inconsistent with the Krakatoa theory.

Dr. Lenz, of St. Petersburg, has devised a telephone for measuring temperatures at a distance. Suppose two stations, A and B, joined by two wires of iron and silver which are soldered at both ends. If the solderings differ in temperature, a thermo-electric current will circulate through the wires, and may be made to express itself by means of a telephonic apparatus; but if the observer, say at A, raises or reduces the temperature of the soldering at his end, till it is identical with the temperature at the end B, the telephone will cease to speak.

OBITUARY NOTES.

M. J. A. Barral, a distinguished French chemist and agronomist, died in September, in the sixty-sixth year of his age. He was Professor of Physics in the College of Sainte-Barbe. In 1850 he made an experimental balloon ascension with M. Bixio, to test the temperature and moisture of the air at different elevations. He founded the "Journal de l'Agriculture," and was commissioned by Arago editor of his works, which were published in seventeen volumes.

Professor J. C. Schioedte, a prominent Danish entomologist and editor of the "Naturhistorisk Tidskrift," of Copenhagen, is dead, at the age of sixty-nine years.

Mr. Charles Manby, engineer, who recently died in England, was for seventeen years paid secretary and for twenty-eight years honorary secretary of the Institution for Civil Engineers. He was the son of Aaron Manby, an eminent iron-manufacturer, and was engaged in the construction of the first pair of marine engines with oscillating cylinders and upon the building of the Aaron Manby, the first iron steamship that ever made a sea-voyage.

Baron Paul Thénard, the eminent French agricultural chemist, has recently died, in the sixty-fifth year of his age. He was a man of immense wealth, and employed it in the service of science. He was the author of investigations on phosphureted hydrogen, the action of the electric spark in chemical combinations, and on numerous questions in agricultural chemistry; and he possessed extensive laboratories at Talmay and in Paris.

Mr. George Bentham, F. R. S., an eminent English botanist, died on the 10th of September last, in the eighty-fourth year of his age. He was a son of General Samuel (afterward Sir Samuel) Bentham, and a nephew of Jeremy Bentham, the famous economist. His attention was attracted to botany, while the family were living in France, by the perusal of De Candolle's "Flore Française," and he immediately took to the study of the flowers in the back yard. His studies were afterward of a more diversified character, while botany still led, till 1829, when he gave up the profession of the law for his favorite science. He studied the enormous collections of the East India Company which had been brought home by Wallich from India; worked out the flora of Hong-Kong and Australia, the latter in seven volumes, containing seven thousand species, for the Royal Gardens at Kew; revised the orders of the *Labiatæ*, *Scrophularinæ*, *Polygoneæ*, etc.; and composed, in association with Hooker, the "Genera Plantarum," a complete general work on the phanerogamic plants, which was completed in the spring of 1883. "He has left no equal," says "Nature," "except Asa Gray."

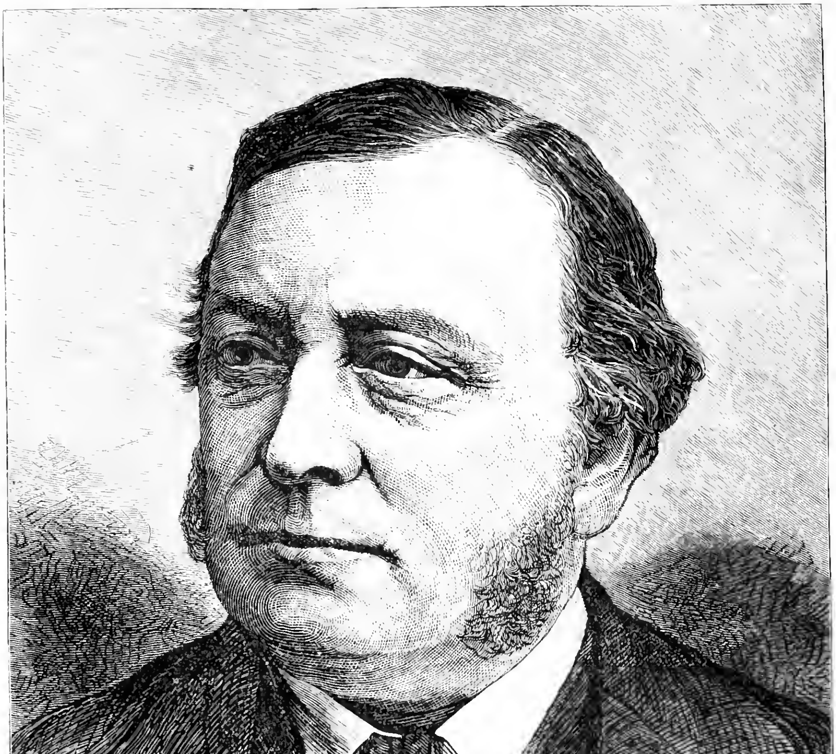
Dr. Joseph Anton Maximilian Perty, Professor of Zoölogy, Psychology, and Anthropology in the University of Berne, died on the 8th of August last, aged eighty years. He was a man of great literary activity in the fields of natural history and metaphysics. Among his works in the latter field were "A Universal Natural History," in four volumes, a treatise on the smallest forms of life, an introduction to the natural sciences, a text-book of zoölogy, outlines of ethnology, and books on anthropology and psychology.

The death of Dr. Heinrich Schellen, author of two well-known works on the electro-magnetic telegraph and spectrum analysis, is reported. Dr. Schellen was formerly director of the Cologne Realschule, and, besides the works named above, published an arithmetic, a German version of Padre Secchi's book on the sun, and other works on physical subjects. He was sixty-six years old.

M. Eugène Bourdon, inventor of the metallic barometer and manometer which are largely used, died in Paris on the 29th of September, aged seventy-six years.

Dr. Settari, an eminent entomologist (particularly in the department of Lepidoptera), has recently died at Meran, Tyrol.

Professor Jakob Natanson, a Polish chemist, died in Warsaw, September 16th. He wrote many scientific books in the Polish language, the most valuable of which were a text-book on chemistry and a treatise on organic chemistry; prepared carbamide synthetically in 1856; and improved the methods for determining the density of vapors.



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A GLANCE AT THE JURY SYSTEM.

BY C. H. STEPHENS.

"Our little systems have their day;
They have their day, and cease to be."

THERE is no one, I fancy, who is in the habit of reading the newspapers, or of witnessing the conduct of jury-trials, but has often had occasion to laugh at the vagaries of juries and their curious verdicts. A volume might be filled with them which would rival in interest Dean Ramsay's "Reminiscences" or Joe Miller's "jokes." "It seems a daring and presumptuous thing," says a learned writer, "to attack as useless an institution on which writers, both lay and legal, have bestowed so much eulogy." And not only does it seem daring and presumptuous, but one can hardly in imagination conceive a time when the jury, with all its record of past services, all its glorious battles for liberty, and all its memories of great pleaders, shall have passed away; when the jury-box, with its "twelve men all arow," shall have disappeared; and when the challenge to the array, and the challenge to the poll, the pathetic addresses of counsel, and the judge's charge, shall be heard of no more forever. Nevertheless, when we see, every month or two, fifty, sixty, or seventy men drafted from the industrial classes to supply what is called a 'petty jury," and a couple of dozen more from, perhaps, a somewhat higher class, to form what is called a "grand jury"; when we see the farmer leave his plow, the builder his building, and the shopkeeper his counter, and come together from places many miles apart; when we see them day after day idling about the courts and taverns; when we see them in the jury-box listening lazily to the proceedings before them; when we hear them delivering

verdicts to which the judgments of Sancho Panza were, in comparison, as the judgments of Solomon; and when we learn that for all this the country pays their traveling expenses, their hotel bills, and so much *per diem* for their services—we can not but believe that the day is not far distant when the jury system, with all its glories and eccentricities, will be a thing of the past. It is rude, clumsy, and out of harmony with the progress of the world. It smacks of a former age and a cruder civilization. It reminds one of the clod of earth, and the lictor's rod; the trial by ordeal, and benefit of clergy. It belongs to these, and not to the age in which we live. With these it arose, and to these it will in time be gathered. The question is, Has not that time arrived now? Is not the world capable of a more perfect system to-day; and if so, what?

No system that can be suggested as superior to the jury can be positively shown in advance to be so. There are so many factors of uncertain quantity which enter into the calculation, that nothing like a perfect estimate of the respective merits of any two systems is possible. By what rule of mathematics can we arrive at the respective wisdom and sagacity of a jury of twelve men as compared with a bench of one, two, or three judges, or their respective honesty, impartiality, and so on? But more, perhaps, in the way of exact calculation is possible than has yet been accomplished. Something is possible, at least, by way of an exact estimate of the relative expense of any two systems. That is one item. Then, something may be done, though perhaps not much, by way of a comparison of the results of a certain term or terms of court in a certain district, where the jury system prevails, with those of a corresponding term or terms in a district where a judge alone decides the questions at issue. In the item of expense must be reckoned the loss to the country by reason of so many persons being taken from their natural employments, the temptations into which they are thrown, and the demoralizing influences to which they are subject. But these calculations pertain more to a commission of inquiry, and I do not propose to enter into them. Neither do I propose to enter, even theoretically, into the great question whether society would not be the gainer in point of morality by an administration of the criminal laws in which a jury would have no part, but merely, by way of introduction to these questions, take a brief glance at what the jury system really is.

It will be admitted, I think, that the jury of real life does not correspond to its ideal. There seems to be a vague, indefinable something about it, which is ever whispering in the ear of Civilization, "Hold fast by me, or you are lost!" But examine the phantom, and it disappears. Whatever of reality it may once have had, has passed away. The language of the old encomiasts would now seem foolish and extravagant. "The jury system," says one writer, "considered as a means of deciding contestations between individuals and of ascertain-

ing the guilt or innocence of accused persons is, in England, the basis of public liberty, the bulwark of the people against oppression, the legal guarantee of life, of honor, and of the property of the citizens. A jury is the buckler of innocence against unjust accusations, and the sworn arbiter of those who have recourse to the tribunals in order to obtain justice. Under this institution the laws may be the means of protection or of destruction, of hope or of misery, according to the spirit, the firmness, and the integrity of the jurors." This is the language of a writer at the beginning of the present century. They are his opening words—the overture, so to speak, of his work. But the qualification he has seen fit to append to it seems, logically, to bring the wordy structure to the ground.

How the jury can be "the basis of public liberty, the bulwark of the oppressed, the buckler of innocence," and so on, and yet depend for all these upon the character of the men who compose it, one can hardly imagine. If the jurymen were all wise, honest, and true—if, in short, they were perfect—we would, undoubtedly, have perfect verdicts. But, if all judges were perfect, the same result would be arrived at in a much simpler way. We can only look for perfect judges and perfect juries when all mankind are perfect; and, when all mankind are perfect, there will be no need of either. And though the jury may have been once all that is thus ascribed to it, how can it be so now? In what manner can it be said to be the basis of public liberty at the present day, and who are the oppressed?

The ideal juryman is not supposed to be more perfect than the ordinary run of mankind; but he is supposed to enter the jury-box free from all prejudices or predilections concerning the matter to be decided. He is supposed to be chosen according to a system which insures the highest degree of impartiality—a system which, in large communities at least, makes the selection of each juror a matter of pure chance. But in such communities there is a large amount of business to be disposed of, and a large number of persons, called a panel, is required, from which each particular jury is taken. This furnishes a considerable quantity of material—of raw material, it may be called—from which the actual twelve are to be selected. These persons are drawn from a class of society the most plastic, the most subject to prejudices and animosities; and it is a well-recognized part of the business of counsel to secure from among them those who may have leanings toward their clients.

Their success or otherwise in this particular is, in all cases of importance, made the subject of the closest calculation. And a counsel is not considered to have shown any marked aptitude if he has not upon the jury one or more upon whose sympathies he can count. The many interests of a national, religious, or friendly character which pervade all society aid in this.

The sympathies of coreligion, copatriotism or confraternity are all

instruments with which the skillful counsel either openly or secretly works.*

The ideal jury is unanimous. The unanimity of the real jury is, in the great majority of cases of any importance, a mere name. That they are required to be unanimous has been admitted from time immemorial to be a defect in the system. The absurdity of *compelling* men to be unanimous must be apparent to the crudest intellects. In olden times in England when the judges "went circuit" they used to carry the jury around with them in carts until they agreed. In our time we have not much advanced beyond this. We lock them up, with barely the necessaries of life, until they are unanimous. The value of a verdict obtained under such conditions is not very evident. In an old case eight of the jury agreed to find "not guilty" and the other four "would find it murder." The next morning two of the four agreed with the eight. At last the rest came to this agreement, viz., that they would offer "not guilty," and if the court disliked it, then they would change the verdict, and find it "guilty"!

The foreman pronounced "not guilty," but the court, "not liking it," examined every one of them by the poll, whether that was their verdict, and ten of them affirmed it, but the last two discovered the whole matter; *whereupon they went back and then brought in "guilty."* The ten were all fined in considerable amounts for their conduct. It is not wonderful that, recognizing, as they must do, the ineffectual nature of their proceedings, jurymen have resorted to the very simple and suggestive expedient of casting lots for their verdict. Several instances are recorded in the books of juries casting lots for it, and in a recent murder trial in England it was discovered that the jury had balloted for their decision. To a candid and independent observer the whole effect of a jury-trial must appear about equivalent to drawing lots. Its value as a means of discovering truth can be little if any beyond this. Any one who will reflect on the matter for a moment will, I think, be convinced that the proportion of correct verdicts can not be much, if any, more than fifty in a hundred, which is, of course, the average in every question of pure chance. Almost every jury-trial is as though the parties acting in it went through a mock solemnity of greater or less duration according to the importance of the case, at the conclusion of which the judge said to the jury: "We have exhibited to you the spectacle of a trial; you will retire now, and cast dice as to what your verdict will be." And if this be true, a system which would dispense with the jury, and in which the court itself would throw the dice, should be quite as satisfactory. It is certain that under such a system the very highest degree of impartiality would be reached, while there would be a vast saving in time and expense.

* The Cincinnati riot, which occurred some time after this was written, would appear to lend additional force to this observation, as it was undoubtedly to one of these causes that the extraordinary verdict which led to the riot was due.

This is in cases where the decision is actually left in the hands of the jury. But, and this is another difference between the real and the ideal in the jury system, we have in a large number of cases the more extraordinary spectacle of a jury solemnly sitting through a trial for the purpose of listening to the evidence and forming their own opinion as to the guilt or innocence of the accused, and then being instructed by the court as to the verdict they shall find. It is, as every one knows, the most common of occurrences for the judge to lecture the jury upon their verdict and to refuse to receive it. That the judge should be more correct than the jury is not impossible, but then—wherefore the jury? In an English case in which the jury had brought in "guilty," Mr. Justice Maule addressed the prisoner as follows: "Prisoner at the bar, your counsel thinks you innocent; the counsel for the prosecution thinks you innocent; I think you innocent. But a jury of your own countrymen, in the exercise of such common sense as they possess, and it does not seem to be much, have found you guilty, and it remains that I should pass upon you the sentence of the law. That sentence is that you be kept in imprisonment for one day, and, as that day was yesterday, you may now go about your business." In a case the other day in San Francisco the judge made similar comments, though to the jury themselves.* The real value of these two anecdotes is ordinarily overlooked. It is something beyond merely raising a laugh at the expense of the jury. The laugh is not necessarily at the expense of the jury at all. It is rather at a system which takes up the time of twelve men in hearing a case and rendering a verdict, and then takes it for granted that the one man who sits on the bench knows more about it than the whole twelve. If the "unanimous" verdict of the twelve is not equal in wisdom to that of the judge who lectures them, it is clear that they may be dispensed with, without any great loss to society.

And, if unlike its ideal, still less is the jury of to-day like its original. A glance at the history of the jury system will show this. The original notion of a jury was not as a protection to anybody. It was not established as a bulwark of popular liberty. The jurymen were witnesses rather than judges of the matter in issue. The modern jury grew by a process of slow and gradual development out of customs which were part of the life of the Anglo-Saxons and other early inhabitants of Great Britain. These customs were perfectly characteristic of a rude, unlettered people. They were perfectly natural. They were based on no recognized legal principle. They had no set purpose in view beyond the purpose of the hour. They were almost utterly devoid of judicial forms. There was no such thing known as a writ. For the hearing of a complaint a messenger was sent personally to

* A notable instance of a judge's overruling the decision of a jury has just occurred in England. In the suit of Adams against Coleridge a verdict was rendered for the plaintiff, and was immediately reversed by the presiding judge.—[EDITOR.

summon the people of the *hundred* in which the dispute arose or the crime was committed. They were to be of the vicinage or neighborhood of the parties. It was necessary that they should know something of the matters in dispute, or the persons accused. They were to decide of their own knowledge. Witnesses in the modern sense were unknown. The parties stated their grievance in the presence of this rude assemblage, which, by a species of acclamation, or preponderance of lung-power, which often terminated in an appeal to brute force, determined the question in issue.

Among the northern tribes something more nearly approaching to a court and jury is said to have existed, but among the Anglo-Saxons judicial forms were of the rudest possible description. By a law of Ethelred twelve men with the sheriff were to go out and discover all who had committed offenses and accuse them. Later grew the practice, introduced by the clergy from the canon law, of swearing the witnesses (as the jury were termed), and of requiring sworn evidence in all cases, both civil and criminal. And by the laws of Edgar it was provided that in every hundred there should be twelve sworn men to be appointed as witnesses, some of whom were to witness every transaction, that they might be afterward called to decide concerning it. The refinements of the ecclesiastical law, and the clergy, who only could read and write, did much to soften the asperities and barbarities of the customs which were in process of time molded into the common law of the country.

The modern jury is no more than the tumultuous assembly of the Anglo-Saxons molded into judicial form by the introduction of sworn evidence, by the separation of the grand and petty juries, and by the establishment of the number twelve—a number common for many purposes among the northern tribes of Europe. In its early stages it had no reference to a dread of monarchical aggression. Witness the fact that Alfred caused forty-four justices to be hanged in one year for delivering false judgments and sentences contrary to the verdict of the jury. From this time the jurisprudence of England rapidly improved. Under the Normans, who succeeded, the jury system showed marked signs of development. In the reign of William II occurred the first instance of twelve men sworn to render a verdict in anything like the modern sense. That was in a cause between the Bishop of Rochester and the sheriff. The jurors, awed by the influence of the sheriff, decided in his favor, which the bishop suspecting, he commanded them to choose twelve men who should confirm it on oath. In this we see the first rudiments of the petty jury.

Another cause which led to the differentiation of the petty jury from the general body of jurors (or witnesses) was what is known in English law as the presentment of Englishry. By a law of the Norman kings, the people of the hundred in which a murder was committed were bound to discover the murderer or pay a fine, unless they proved

that the person murdered was English. As this last was a task usually attended with great difficulty, it became the practice of the people of the hundred to discover the criminal, and, when found, to accuse him of the crime ; but as these accusers, when they had apprehended the accused, were found liable to be prejudiced against him, the custom grew of choosing twelve, who might be taken, not only from the hundred, but from the whole body of the county, whose functions were to decide as to the guilt or innocence of the accused. Under the first Henry the jurors, though still witnesses, and deciding exclusively from their own knowledge, began to be called judges—a fact which seems to indicate that the office of deciding began to be recognized as the principal part of their duty. In the following reign, Henry II recognized the value of the jury system as a check upon the power and rapacity of the barons ; and, consequently, in the tenth year of his reign, was enacted the first legislation on record establishing the right of trial by jury. In the constitutions of Clarendon, passed in that year, it was provided that laymen should not be accused unless by certain legal accusers, the witnesses, *and that if the offenders were such whom no one wished or desired to accuse*, that then twelve men should be sworn "who should declare the truth according to their conscience."

It is noted as a curious fact that the jury system, whose great value has always been as a means of checking the encroachments of the crown upon popular liberty, should thus have been first officially introduced to the world as a means of strengthening the crown in its endeavors to check the encroachments of others. And it may be noted as an equally curious fact that the importance of the jury, as thus first established, was in gaining convictions rather than in evading them. Jurors, however, were still witnesses—"deciding by what they had seen and heard." Indeed, it was not until the reign of Henry VI (fifteenth century) that jurors were of sufficient intelligence to listen to and decide upon extraneous evidence ; and not until the reign of Anne (eighteenth century) that it was enacted that the want of "hundredors" should not be a cause of challenge to the jury.

From this brief recital it will be seen that the last stage in the development of the modern jury was reached when, in the fifteenth century, the jurors began to listen to the evidence of others, and ceased to rely upon their own. The importance of the jury prior to this period has been very much overstated. The reference to it in Magna Charta does not warrant all the eloquence that has been expended upon it. The events which gave rise to Magna Charta and the condition of the people of England at that time preclude the idea that the jury system owes its existence, or at any rate its place in Magna Charta, to the "freedom-loving instincts of the Anglo-Saxons." A proper conception of the jury itself, as it then existed, equally precludes the idea that it possessed the importance, even in the eyes of those who obtained the charter, which people in later times have been

wont to attach to it. Among the phenomena of human life is this, that in all countries and ages certain ideas or beliefs have been found so pleasing to the national vanity as to be regarded as the most fundamental of truths. They have descended from generation to generation as a sort of popular inheritance. They have formed part of the education of youth and the entertainment of maturer age. They have been placed, so to speak, in the national Pantheon, and worshiped as at least half divine.

No one ever thought of doubting them, because to do so would be sacrilege; to deny them, a crime. Instances of this will occur to every one, and no more marked instance can be found than this, that we owe trial by jury to the wisdom, courage, and foresight of the Anglo-Saxons of the reign of John. A reference to the circumstances of that period will make this evident.

In consequence of their miserable condition, the hardships and exactions of the feudal system, and the cruelty and rapacity of those above them, the Anglo-Saxons, who constituted the lowest orders of the people at that time, were crying out for a return to the laws and customs of the Anglo-Saxon period. These customs included, as we have seen, a sort of trial by jury of the crudest and most rudimentary kind. But it was not for this they cried. This, such as it was, they had never lost. Under the Norman kings it was encouraged rather than suppressed, and in the reign of John had advanced far toward a regular judicial system. To this extent only can the reference to trial by jury in Magna Charta be ascribed to the Anglo-Saxons—viz., that it was one of the customs of the English people descended from the Anglo-Saxon period, confirmed by many subsequent charters, and enrolled in the great charter as part of the national constitution. To understand this it is indispensable to remember what the great charter was, and how little in reality the lower orders had to do with it. The struggle out of which it arose was not with them at all. It was a contest between the king and the barons, who set at naught his authority, who hanged his officers, and who rebelled against his outrages and abuses. It was they, the greatest enemies of the Anglo-Saxons, whose interest was in framing the laws so that they might ravage the common people with impunity, and at the same time escape similar treatment on the part of the king, who compelled the latter to sign Magna Charta. And so clearly were their interests opposed to the system of trial by jury, that it has been confidently asserted that the famous jury clause was due to the king himself. It seems more reasonable, however, to ascribe it to the archbishop and the clergy, by whom the document was undoubtedly drawn, and to whom its peculiar phraseology is undoubtedly due. But what is more credible, and, if true, more important, is the assertion on high authority that the words *judicium parium*, or judgment of peers, which are supposed to embody the great central principle of trial by jury, do not refer to

criminal matters at all—the decision in which was never termed *judicium*, but *veridictum*. So that the most that can with safety be asserted of these two famous words is this, that out of them was evolved the great principle which in after-years was to stand in the breach in many a bitter struggle between law and force, and to play so important a part in the history of civilization.

And indeed that is the light in which the whole of this great act is to be regarded. It is all of a piece with the *judicium parium* and *habeas corpus* clause, the assertion of the supremacy of law in all ranks and orders of society. Laws had existed before the time of John, but they were but additional instruments in the hands of the strong to oppress the weak. Under the Saxon kings the laws were neither understood nor regarded. Every man was a law unto himself, and the result was anarchy and barbarism.

Under the Norman kings law was recognized and partially understood, but it was enforced only against those least powerful to violate it. Each Norman king in turn granted and confirmed the laws to the people, but himself outraged every law, both human and divine. The feudal lords right nobly imitated their example ; and, so great grew their exactions that, like the Hebrews of old, the people cried aloud for a deliverer. The deliverer came in the person of a king more sensual, more vile, and more tyrannical than any who had preceded him ; a king who ground the faces of the rich as well as of the poor ; who outraged the noble as well as the base-born ; who oppressed the strong as well as the weak. And the rich and the noble and the strong stood up ; the barons turned against the king, and the king against the barons, and out of the contest arose the supremacy of the law. Law became the sole arbiter of right and wrong among all classes, and force and violence and the savage instincts of man became subject thereto.

For upward of five centuries the principles of Magna Charta have governed the Anglo-Saxon world, and among them the principle of trial by jury has held its place. The tyranny of absolute monarchy is gone, and the brutality of the barons has long since passed away, but the jury system remains. Since the days of William III, when the supremacy of the law was finally vindicated, and the judges were made independent of the crown, trial by jury has been little more than a form ; yet English-speaking people everywhere cling to it as a lately bereaved wife clings to the form of him who through many long years has been her shield and protector.

In this age all men are peers and equals in the eyes of the law, yet a jury of twelve, with all its ancient crudities, and all its modern anomalies, is still considered essential to a fair and impartial trial.

Time was when the jury were judges of the law as well as the fact. To-day they are in fact judges of neither. They are but the echo of the court, and their principal office is to relieve the court of the respon-

sibility of what is done. When a judge sentences a prisoner, he says, in effect: "Do not blame me, I pray you. You have been condemned by the 'unanimous' verdict of twelve of your fellows. I am but the mouth-piece of the law to pass sentence according to their verdict." Of course this is not so. In a great proportion of cases the very reverse is the case. The jury are, in fact, but the mouth-piece of the judge to render a verdict, the responsibility of which he wishes to be relieved of.

Let us ask ourselves if there really is anything to be gained by the continuance of a system so full of incongruities. People are commencing to ask this question now. One authority says, "Apart from any incidental defects, it may be doubted whether, as an instrument for the investigation of truth, the jury deserves all the encomiums that have been passed upon it." But the same writer goes on to point out that, while the jury might with advantage be dispensed with in civil cases, "opinion in England is unanimously against subjecting a man to serious punishment without the verdict of a jury, and the judges themselves," he adds, "would be the first to deprecate so great a responsibility." But that public sentiment is in favor of the jury system does not prove it to be the best, even in criminal cases. Mere sentiment is not an argument for the continuance of any system, and moral cowardice is not even an apology for one. Every system, every institution, however useful in the past, whatever may be its claims on the reverence or affection of mankind, must, sooner or later, be brought to the test of present and practical worth. In the Bank of England one is shown a very delicate and ingenious instrument for weighing coins. The coins pass up a tube, at the top of which they pause for a moment and are weighed. If good, they drop into a receiver on the one hand; if bad, they infallibly go to the other. No human agency is visible, yet each in its turn which does not come up to the standard of this remorseless little instrument is cast aside and rejected. All the institutions of the past are coins for which the age has invented weighing-machines. Each must come up to the standard of actual value, of undoubted utility, or be cast aside. The jury system will be no exception to these. In several countries it is now only used in civil matters. Throughout the Austrian Empire it has been abolished entirely. Law everywhere is undergoing a process of simplification. In English-speaking countries in particular it has, during the last few years, been purged of many abuses, stripped of much that was useless, and, in a few years more, trial by jury will also be swept away.

AGNOSTIC METAPHYSICS.

By FREDERIC HARRISON.

TEN years ago I warned Mr. Herbert Spencer that his Religion of the Unknowable was certain to lead him into strange company. "To invoke the Unknowable," I said, "is to reopen the whole range of Metaphysics; and the entire apparatus of Theology will follow through the breach." I quoted Mr. G. Lewes's admirable remark,* "that the foundations of a Creed can rest only on the Known and the Knowable." We see the result. Mr. Spencer has developed his Unknowable into an "Infinite and Eternal Energy, by which all things are created and sustained." He has discovered it to be the Ultimate Cause, the All-Being, the Creative Power, and all the other "alternative impossibilities of thought" which he once cast in the teeth of the older theologies. Naturally there is joy over one philosopher that repenteth. The "Christian World" claims this as equivalent to the assertion that God is the mind and spirit of the universe; and the "Christian World" says these words might have been used by Butler or Paley.† This is, indeed, true; but it is strange to find the philosophy of one who makes it a point of conscience not to enter a church described as "the fitting and natural introduction to inspiration!"

The admirers of Mr. Spencer's genius—and I count myself among the earliest—will not regret that he has been induced to lay aside his vast task of philosophic synthesis, in order more fully to explain his views about Religion. This is, indeed, for the thoughtful, as well as the practical, world, the great question of our age, and the discussion that was started by his paper ‡ and by mine # has opened many topics of general interest. Mr. Spencer has been led to give to some of his views a certainly new development, and he has treated of matters which he had not previously touched. Various critics have joined the debate. Sir James Stephen ‖ has brought into play his Nasmyth hammer of Common Sense, and has asked the bold and truly characteristic question: "Can we not do just as well without any religion at all?" The weekly Reviews, I am told, have been poking at us their somewhat hebdomadal fun. And then Mr. Wilfrid Ward,△ "the rising hope of the stern and unbending" Papists, steps in to remind us of the ancient maxim—*extra Ecclesiam nulla salus.*

I can not altogether agree with a friend who tells me that contro-

* "Problems of Life and Mind," vol. i. Preface.

† "The Christian World," June 5 and July 3, 1884.

‡ H. Spencer, in "Nineteenth Century," January and July, 1884.

\# F. Harrison, in "Nineteenth Century," March, 1884.

‖ Sir J. Stephen, in "Nineteenth Century," June, 1884.

△ W. Ward, in "National Review," June, 1884.

versy is pure evil. It is not so when it leads to a closer sifting of important doctrines; when it is inspired with friendly feeling, and has no other object than to arrive at the truth. There were no mere "compliments" in my expressions of respect for Mr. Spencer and his work. I habitually speak of him as the only living Englishman who can fairly lay claim to the name of philosopher; nay, he is, I believe, the only man in Europe now living who has constructed a real system of philosophy. Very much in that philosophy I willingly adopt; as a philosophical theory I accept his idea of the Unknowable. My rejection of it as the basis of Religion is no new thing. The substance of my essay on the "Ghost of Religion" I have long ago taught at Newton Hall. The difference between Mr. Spencer and myself as to what religion means is vital and profound. So deep is it that it justifies me in returning to these questions, and still further disturbing his philosophic labor. But our long friendship, I trust, will survive the inevitable dispute.

It will clear up much at issue between us if it be remembered that to me this question is one primarily of religion; to Mr. Spencer, one primarily of philosophy. He is dealing with transcendental conceptions, intelligible only to certain trained metaphysicians: I have been dealing with religion as it affects the lives of men and women in the world. Hence, if I admit with him that philosophy points to an unknowable and inconceivable Reality behind phenomena, I insist that, to ordinary men and women, an unknowable and inconceivable Reality is practically an Unreality. The Everlasting Yes which the Evolutionist metaphysician is conscious of, but can not conceive, is in effect on the public a mere Everlasting No; and a religion which begins and ends with the mystery of the Unknowable is not religion at all, but a mere logician's formula. This is how it comes about that Mr. Spencer complains that I have misunderstood him or have not read his books, that I fail to represent him, or even misrepresent him. I can not admit that I have either misunderstood him or misrepresented him on any single point. I have studied his books part by part and chapter by chapter, and have examined the authorities on which he relies.

He seems to think that all hesitation to accept his views will disappear if men will only turn to his "First Principles," his "Principles of Sociology," and his "Descriptive Sociology," where he has "proved" this and "disproved" that, and arrayed the arguments and the evidence for every doctrine in turn. Now, for my part, I have studied all this, to my great pleasure and profit, since the first number of "A Synthetic Philosophy" appeared. Mr. Spencer objects to discipleship, or I would say that I am in very many things one of his disciples myself. But in this matter of religion I hold still, as I have held from the first, that Mr. Spencer is mistaken as to the history, the nature, and the function of religion. It is quite true that he and I are at

opposite poles in what relates to the work of religion on man and on life. In all he has written, he treats religion as mainly a thing of the mind, and concerned essentially with mystery. I say—and here I am on my own ground—that religion is mainly a thing of feeling and of conduct, and is concerned essentially with duty. I agree that religion has also an intellectual base; but here I insist that this intellectual basis must rest on something that can be known and conceived and at least partly understood; and that it can not be found at all in what is unknowable, inconceivable, and in no way whatever to be understood.

Now, in maintaining this, I have with me almost the whole of the competent minds which have dealt with this question. Mr. Spencer puts it rather as if it were merely fanaticism on my part which prevents me from accepting his theory of Religion; as if Sir James Stephen's difficulties would disappear if he could be induced to read the "Principles of Sociology" and the rest. Mr. Spencer must remember that in his Religion of the Unknowable he stands almost alone. He is, in fact, insisting to mankind, in a matter where all men have some opinion, on one of the most gigantic paradoxes in the history of thought. I know myself of no single thinker in Europe who has come forward to support this religion of an Unknowable Cause, which can not be presented in terms of consciousness, to which the words emotion, will, intelligence can not be applied with any meaning, and yet which stands in the place of a supposed anthropomorphic Creator. Mr. George H. Lewes, who of all modern philosophers was the closest to Mr. Spencer, and of recent English philosophers the most nearly his equal, wrote ten years ago: "Deeply as we may feel the mystery of the universe and the limitations of our faculties, *the foundations of a creed can only rest on the Known and the Knowable.*" With that I I believe every school of thought but a few dreamy mystics has agreed. Every religious teacher, movement, or body, has equally started from that. For myself, I feel that I stand alongside of the religious spirits of every time and of every church in claiming for religion some intelligible object of reverence, and the field of feeling and of conduct, as well as that of awe. Every notice of my criticism of Mr. Spencer which has fallen under my eye adopted my view of the hollowness of the Unknowable as a basis of Religion. So say Agnostics, Materialists, Sceptics, Christians, Catholics, Theists, and Positivists. All with one consent disclaim making a Religion of the Unknowable. Mr. Herbert Spencer may construct an Athanasian Creed of the "Inscrutable Existence"—which is neither God nor being—but he stands as yet *Athanasius contra mundum.* It is not, therefore, through the hardness of my heart and the stiffness of my neck that I can not follow him here.

Let us now sum up the various positions which Mr. Spencer would impose on us as to Religion. After his two articles and the recent

discussion we can hardly mistake him, and they justify my saying that they form a gigantic paradox. Mr. Spencer maintains that:

1. The proper object of Religion is a Something which can never be known, or conceived, or understood; to which we can not apply the terms emotion, will, intelligence; of which we can not affirm or deny that it is either person, or being, or mind, or matter, or indeed anything else.

2. All that we can say of it is, that it is an Inscrutable Existence or an Unknowable Cause: we can neither know nor conceive what it is, nor how it came about, nor how it operates. It is, notwithstanding, the Ultimate Cause, the All-Being, the Creative Power.

3. The essential business of religion, so understood, is to keep alive the consciousness of a mystery that can not be fathomed.

4. We are not concerned with the question, "What effect this religion will have as a moral agent?" or, "Whether it will make good men and women?" Religion has to do with mystery, not with morals.

These are the paradoxes to which my fanaticism refuses to assent.

Now these were the views about Religion which I found in Mr. Spencer's first article, and they certainly are repeated in his second. He says: "The Power which transcends phenomena can not be brought within the forms of our finite thought" "The Ultimate Power is not representable in terms of human consciousness." "The attributes of personality can not be conceived by us as attributes of the Unknown Cause of things." "The nature of the Reality transcending appearances can not be known, yet its existence is necessarily implied." "No conception of this Reality can be framed by us." "This Inscrutable Existence which Science, in the last resort, is compelled to recognise as unreached by its deepest analyses of matter, motion, thought, and feeling." "In ascribing to the Unknowable Cause of things such human attributes as emotion, will, intelligence, we are using words which, when thus applied, have no corresponding ideas. There can be no kind of doubt about all this. I said Mr. Spencer proposes, as the object of religion, an abstraction which we can not conceive, or present in thought, or regard as having personality, or as capable of feeling, purpose, or thought—in familiar words, I said it was "a sort of a something, about which we can know nothing."

Mr. Spencer complains that I called this Something a negation, an All-Nothingness, an (x^n), and an Everlasting No. He now says that this Something is the All-Being. The Unknowable is the Ultimate Reality—the sole existence;—the entire Cosmos, as we are conscious of it, being a mere show. In familiar words:—"Everything is nought, and the Unknowable is the only real Thing." I quite agree that this is Mr. Spencer's position as a metaphysician. It is not at all new to me, for it is worked out in his "First Principles" most distinctly. Ten years ago, when I reviewed Mr. Lewes's "Problems of Life and

Mind," I criticised Mr. Spencer's Transfigured Realism as being too absolute.* I then stated my own philosophical position to be that, "our scientific conceptions within have a good working correspondence with an (assumed) reality without—we having no means of knowing whether the absolute correspondence between them be great or small, or whether there be any absolute correspondence at all." To that I adhere; and, whilst I accept the doctrine of an Unknown substratum, I can not assent to the doctrine that the Unknowable is the Absolute Reality. But I am quite aware that he holds it, nor have I ever said that he did not. On the contrary, I granted that it might be the first axiom of science or the universal postulate of philosophy. But it is not a religion.†

I said then, and I say still, speaking with regard to religion, and from the religious point of view, that the Metaphysician's Unknowable is tantamount to a Nothing. The philosopher may choose to say that there is an Ultimate Reality which we can not conceive, or know, or liken to anything we do know. But these subtleties of speculation are utterly unintelligible to the ordinary public. And to tell them that they are to worship this Unknowable is equivalent to telling them to worship nothing. I quite agree that Mr. Spencer, or any metaphysician, is entitled to assert that the Unknowable is the sole Reality. But religion is not a matter for Metaphysicians—but for men, women, and children. And to them the Unknowable is Nothing. Sir James Stephen calls the distinctions of Mr. Spencer "an unmeaning play of words." I do not say that they are unmeaning to the philosophers working on metaphysics. But to the public, seeking for a religion, the Reality or the Unreality of the Unknowable is certainly an unmeaning play of words.

Even supposing that Evolution ever could bring the people to comprehend the subtlety of the All-Being, of which all things we know are only shows, the Unknowable is still incapable of supplying the very elements of Religion. Mr. Spencer thinks otherwise. He says, that although we can not know, or conceive it, or apply to it any of the terms of life, or of consciousness, "it leaves unchanged certain of the sentiments comprehended under the name of religion." "Whatever components of the religious sentiment disappear, there must ever survive those which are appropriate to the consciousness of a Mystery!" Certain of the religious sentiments are left unchanged! The consciousness of a Mystery is to survive! Is that all? "We are not concerned," says he, "to know what effect this religious sentiment will have as a moral agent!" A religion without anything to be known, with nothing to teach, with no moral power, with some rags of religious

* "Fortnightly Review," 1874, p. 89.

† My words were that, "although the Unknowable is logically said to be Something, yet the something of which we neither know nor conceive anything is practically nothing." That is, speaking from the point of view of religion.

sentiment surviving, mainly the consciousness of Mystery ; this is, indeed, the mockery of Religion.

Forced, as it seems, to clothe the nakedness of the Unknowable with some shreds of sentiment, Mr. Spencer has given it a positive character, which for every step that it advances towards Religion recedes from sound Philosophy. The Unknowable was at first spoken of as an "unthinkable abstraction," and so undoubtedly it is. But it finally emerges as the Ultimate Reality, the Ultimate Cause, the All-Being, the Absolute Power, the Unknown Cause, the Inscrutable Existence, the Infinite and Eternal Energy, from which all things proceed, the Creative Power, "the Infinite and Eternal Energy, by which all things are created and sustained." It is "to stand in substantially the same relation towards our general conception of things as does the Creative Power asserted by Theology.' "It stands towards the Universe, and towards ourselves, in the same relation as an anthropomorphic Creator was supposed to stand, bears a like relation with it, not only to human thought but to human feeling." In other words the Unknowable *is* the Creator ; subject to this, that we can not assert or deny that he, she, or it, is Person, or Being, or can feel, think, or act, or do anything else that we can either know or imagine, or is such that we can ascribe to Him, Her, or It anything whatever within the realm of consciousness.

Now, the Unknowable, so qualified and explained, offends against all the canons of criticism, so admirably set forth in "First Principles," and especially those of Dean Mansel, therein quoted and adopted. The Unknowable is not unknowable if we know that "it creates and sustains all things." One need not repeat all the metaphysical objections arrayed by Mr. Spencer himself against connecting the ideas of the Absolute, the Infinite, First Cause, and Creator with that of any one Power. How can Absolute Power create? How can the Absolute be a Cause? The Absolute excludes the relative ; and Creation and Cause both imply relation. How can the Infinite be a Cause, or create? For if there be effect distinct from cause, or if there be something uncreated, the Infinite would be thereby limited. What is the meaning of All-Being? Does it include, or not, its own manifestation? If the Cosmos is a mere show of an Unknown Cause, then the Unknown Cause is not Infinite, for it does not include the Cosmos ; and not Absolute, for the Universe is its manifestation, and all things proceed from it. That is to say, the Absolute is in relation to the Universe, as Cause and Effect. Again, if the "very notions, beginning and end, cause and purpose, relative notions belonging to human thought, are probably irrelevant to the Ultimate Reality transcending human thought" (Spencer, "Nineteenth Century," p. 12), how can we speak of the Ultimate Cause, or indeed of Infinite and Eternal? The philosophical difficulties of imagining a First Cause, so admirably put by Mr. Spencer years ago, are not greater than those of imagining an

Ultimate Cause. The objections he states to the idea of Creation are not removed by talking of a Creative Power rather than a Creator God. If Mr. Spencer's new Creative Power "stands towards our general conception of things in substantially the same relation as the Creative Power of Theology," it is open to all the metaphysical dilemmas so admirably stated in "First Principles." Mr. Spencer can not have it both ways. If his Unknowable be the Creative Power and Ultimate Cause, it simply renews all the mystification of the old theologies. If his Unknowable be unknowable, then it is idle to talk of Infinite and Eternal Energy, sole Reality, All-Being, and Creative Power. This is the slip-slop of theologians which Mr. Spencer, as much as any man living, has finally torn to shreds.

In what way does the notion of Ultimate Cause avoid the difficulties in the way of First Cause, and how is Creative Power an idea more logical than Creator? And if, as Mr. Spencer says ("First Principles," p. 35), "the three different suppositions respecting the origin of things turn out to be literally unthinkable," what does he mean by asserting that a Creative Power is the one great Reality? Mr. Spencer seems to suggest that, though all idea of First Cause, of Creator, of Absolute Existence is unthinkable, the difficulty in the way of predicating them of anything is got over by asserting that the unthinkable and the unknowable is the ultimate reality. He said ("First Principles," p. 110), "every supposition respecting the genesis of the Universe commits us to alternative impossibilities of thought;" and again, "we are not permitted to know—nay, we are not even permitted to conceive—that Reality which is behind the veil of Appearance." Quite so! On that ground we have long rested firmly, accepting Mr. Spencer's teaching. It is to violate that rule if we now go on to call it Creative Power, Ultimate Cause, and the rest. It comes then to this: Mr. Spencer says to the theologians, "I can not allow you to speak of a First Cause, or a Creator, or an All-Being, or an Absolute Existence, because you mean something intelligible and conceivable by these terms, and I tell you that they stand for ideas that are unthinkable and inconceivable. But," he adds, "I have a perfect right to talk of an Ultimate Cause and a Creative Power, and an Absolute Existence, and an All-Being, because I mean nothing by these terms—at least, nothing that can be either thought of or conceived of, and I know that I am not talking of anything intelligible or conceivable. That is the faith of an Agnostic, which except a man believe faithfully he can not be saved."

Beyond the region of the knowable and the conceivable we have no right to assume an infinite energy more than an infinite series of energies, or an infinite series of infinite things or nothings. We have no right to assume one Ultimate Cause, or any cause, more than an infinite series of Causes, or something which is not Cause at all. We have no right to assume that anything beyond the knowable is eternal

or infinite, or anything else; we have no right to assume that it is the Ultimate Reality. There may be an endless circle of Realities, or there may be no Reality at all. Once leave the region of the knowable and the conceivable, and every positive assertion is unwarranted. The forms of our consciousness prove to us, says Mr. Spencer, that what lies behind the region of consciousness is not merely unknown but unknowable, that it is one, and that it is Real. The laws of mind, I reply, do not hold good in the region of the unthinkable; the forms of our consciousness can not limit the Unknowable. All positive assertions about that "which can not be brought within the forms of our finite thought" are therefore unphilosophical. We have always held this of the theological Creation, and we must hold it equally of the evolutionist Creation. Here is the difference between Positive Philosophy and Agnostic Metaphysics.

But if this Realism of the Unknowable offends against sound philosophy, the Worship of the Unknowable is abhorrent to every instinct of genuine Religion. There is something startling in Mr. Spencer's assertion that he "is not concerned to show what effect this religious sentiment will have as a moral agent." As in "First Principles," so now, he represents the business of Religion to be to keep alive the consciousness of a Mystery. The recognition of this supreme verity has been from the first, he says, the vital element of Religion. From the beginning it has dimly discerned this ultimate verity; and that supreme and ultimate verity is, that there is an inscrutable Mystery. If this be not retrogressive Religion, what is? Religion is not indeed to be discarded; but, in its final and perfect form, all that it ever has had of reverence, gratitude, love, and sympathy, is to be shrivelled up into the recognition of a Mystery. Morality, duty, goodness are no longer to be within its sphere. It will neither touch the heart of men nor mould the conduct; it will perpetually remind the intelligence that there is a great Enigma, which, it tells us, can never be solved. Not only is religion reduced to a purely mental sphere, but its task in that sphere is one practically imbecile.

Mr. Spencer complains that I called his Unknowable "an ever-present conundrum to be everlastingly given up." But he uses words almost exactly the same; he himself speaks of "the Great Enigma which he (man) knows can not be solved." The business of the religious sentiment is with "a consciousness of a Mystery that can not be fathomed." It would be difficult to find for Religion a lower and more idle part to play in human life than that of continually presenting to man a conundrum, which he is told he must continually give up. One would take all this to be a bit from "Alice in Wonderland," rather than the first chapter of "Synthetic Philosophy."

I turn to some of the points on which Mr. Spencer thinks that I misunderstand or misrepresent his meaning. I can not admit any one

of these cases. In calling the Unknowable a pure negation, I spoke from the standpoint of Religion, not of Metaphysics. It may be a logical postulate, but that of which we can know nothing, and of which we can form no conception, I shall continue to call a pure negation, *as an object of worship*, even if I am told (as I now am) that it is that "by which all things are created and sustained." Such is the view of Sir James Stephen, and of every other critic who has joined in this discussion.

With respect to Dean Mansel I made no mistake; the mistake is Mr. Spencer's—not mine. I said that of all modern theologians the Dean came the nearest to him. As we all know, in "First Principles" Mr. Spencer quotes and adopts four pages from Mansel's "Bampton Lectures." But I said "there is a gulf which separates even his all-negative *deity* from Mr. Spencer's impersonal, unconscious, unthinking, and unthinkable Energy." Mr. Spencer says that I misrepresent him and transpose his doctrine and Mansel's, because he regards the Absolute as positive and the Dean regarded it as negative. If Mr. Spencer will look at my words again, he will see that I was speaking of Mansel's Theology, not of his Ontology. I said "*deity*," not the Absolute. Mansel, as a metaphysician, no doubt spoke of the Absolute as a negative, whilst Mr. Spencer speaks of it as positive. But Mansel's idea of deity is personal, whilst Mr. Spencer's Energy is not personal. That is strictly accurate. Dean Mansel's words are, "it is our duty to think of God as personal;" Mr. Spencer's words are, "duty requires us neither to affirm nor to deny personality" of the Unknown Cause. That is to say, the Dean called his First Cause God; Mr. Spencer prefers to call it Energy. Both describe this First Cause negatively; but whilst the Dean calls it a Person, Mr. Spencer will not say that it is person, conscious, or thinking. Mr. Spencer's impression then that I misrepresented him in this matter is simply his own rather hasty reading of my words.

It is quite legitimate in a question of religion and an object of worship to speak of this Unknowable Energy, described as Mr. Spencer describes it, as "impersonal, unconscious, unthinking, and unthinkable." The distinction that, since we neither affirm nor deny of it personality, consciousness, or thought, it is not therefore impersonal, is a metaphysical subtlety. That which can not be presented in terms of human consciousness is neither personal, conscious, nor thinking, but properly unthinkable. To the ordinary mind it is a logical formula, it is apart from man, it is impersonal and unconscious. And to tell us that this conundrum is "the power which manifests itself in consciousness," that man and the world are but its products and manifestations, that it may have (for aught we know) something higher than personality and something grander than intelligence, is to talk theologico-metaphysical jargon, but is not to give the average man and woman any positive idea at all, and certainly not a religious idea.

In religion, at any rate, that which can only be described by negations is negative; that which can not be presented in terms of consciousness is unconscious.

I shall say but little about Mr. Spencer's Ghost theory as the historical source of all religion; because it is, after all, a subordinate matter, and would lead to a wide digression. I am sorry that he will not accept my (not very serious) invitation to him to modify the paradoxes thereon to be read in his "Principles of Sociology." I have always held it to be one of the most unlucky of all his sociologic doctrines, and that on psychological as well as on historical grounds. Mr. Spencer asserts that all forms of religious sentiment spring from the primitive idea of a disembodied double of a dead man. I assert that this is a rather complicated and developed form of thought; and that the simplest and earliest form of religious sentiment is the idea of the rudest savage, that visible objects around him—animal, vegetable, and inorganic—have quasi-human feelings and powers, which he regards with gratitude and awe. Mr. Spencer says that man only began to worship a river or a volcano when he began to imagine them as the abode of dead men's *spirits*. I say that he began to fear or adore them, so soon as he thought the river or the volcano had the feelings and the powers of living beings; and that was from the dawn of the human intelligence. The latter view is, I maintain, far the simpler and more obvious explanation; and it is a fault in logic to construct a complicated explanation when a simple one answers the facts. Animals think inert things of a peculiar form to be animal; so do infants. The dog barks at a shadow; the horse dreads a steam-engine; the baby loves her doll, feeds her, nurses her, and buries her. The savage thinks the river, or the mountain beside which he lives, the most beneficent, awful, powerful of beings. There is the germ of religion. To assure us that the savage has no feeling of awe and affection for the river and the mountain, until he has evolved the elaborate idea of disembodied spirits of dead men dwelling invisibly inside them, is as idle as it would be to assure us that the love and the terror of the dog, the horse, and the baby are due to their perceiving some disembodied spirit inside the shadow, the steam-engine, or the doll.

I think it a little hard that I may not hold this common-sense view of the matter, along with almost all who have studied the question, without being told that it comes of "persistent thinking along defined grooves," and that I should accept the Ghost theory of Religion were it not for my fanatical discipleship. Does not Mr. Spencer himself persistently think along defined grooves; and does not every systematic thinker do the same? But it so happens that the Ghost theory leads to conclusions that outrage common sense. If Dr. Tylor has finally adopted it, I am sorry. But it is certain that the believers in the Ghost theory as the origin of all forms of Religion are few and far between. The difficulties in the way of it are enormous. Mr.

Spencer laboriously tries to persuade us that the worship of the Sun and the Moon arose, not from man's natural reverence for these great and beautiful powers of Nature, but solely as they were thought to be the abodes of the disembodied spirits of dead ancestors. Animal worship, tree and plant worship, fetichism, the Confucian worship of heaven, all, he would have us believe, take their origin entirely from the idea that these objects contain the spirits of the dead. If this is not "persistent thinking along defined grooves," I know not what it is.

The case of China is decisive. There we have a religion of vast antiquity and extent, perfectly clear and well ascertained. It rests entirely on worship of Heaven, and Earth, and objects of Nature, regarded as organized beings, and not as the abode of human spirits. There is in the religion and philosophy of China no notion of human *spirits*, disembodied and detached from the dead person, conceived as living in objects and distinct from dead bodies. The dead are the dead; not the spiritual denizens of other things. In the face of this, the vague language of missionaries and travellers as to the beliefs of savages must be treated with caution. Mr. Spencer speaks in too confident language of his having "proved" and "disproved" and "shown" all these things in his "Descriptive Sociology" and in his "Principles of Sociology." How many competent persons has he convinced? Assuredly, for my part, I read and re-read all that he there says about the genesis of religion with amazement. We read these authorities for ourselves, and we can not see that they bear out his conclusions. It was a pity to refer to the tables in the "Descriptive Sociology," perhaps the least successful of all Mr. Spencer's works. That work is a huge file of cuttings from various travellers of all classes, extracted by three gentlemen whom Mr. Spencer employed. Of course these intelligent gentlemen had little difficulty in clipping from hundreds of books about foreign races sentences which seem to support Mr. Spencer's doctrines. The whole proceeding is too much like that of a famous lawyer who wrote a law-book, and then gave it to his pupils to find the "cases" which supported his law. It is a little suspicious that we find so often at the head of each "susperstition" of the lower races a heading in almost the same words to the effect: "Dreams, regarded as visits from the spirits of departed relations." The intelligent gentlemen employed have done their work very well; but of course one can find in this medley of tables almost any view. And I find facts which make for my view as often as any other.

Fetichism, says Mr. Spencer, is not found in the lowest races. Be that as it may, it is found wherever we can trace the germs of religion. Well, I read in the "Descriptive Sociology" that Mr. Burton, perhaps the most capable of all African travellers, declares that "fetichism is still the only faith known in East Africa." In other places, we read of the sun and moon, forests, trees, stones, snakes, and the like regarded with religious reverence by the savages of Central Africa.

"The Damaras attribute the origin of the sheep to a large stone." They regard a big tree as the origin of Damaras. "Cattle of a certain color are venerated by the Damaras." "To the Bechuanas rain appears as the giver of all good." The negro whips or throws away a worthless fetich. "The Hottentots and Bushmen shoot poisoned arrows at the lightning and throw old shoes at it." Exactly! And do these Damaras, Bechuanas, and Bushmen do this solely because they think that the sun and moon, the lightning, the rain, the trees, the cattle, and the snakes are the abodes of the disembodied spirits of their dead relatives? And do they never do this until they have evolved a developed Ghost theory?

This is more than I can accept, for all the robustness of faith which Mr. Spencer attributes to me. Whilst I find in a hundred books that countless races of Africa and the organized religion of China attribute human *qualities* to natural objects, and grow up to regard those objects with veneration and awe, I shall continue to think that fetichism, or the reverent ascription of feeling and power to natural objects, is a spontaneous tendency of the human mind. And I shall refuse, even on Mr. Spencer's high authority, and that of his three compilers, to believe that it is solely a result of a developed *Ghost theory*. To ask us to believe this as "proved" on the strength of a pile of clippings made to order is, I think, quite as droll to ordinary minds as anything Mr. Spencer can pick up out of the Positivist Calendar.—*Nineteenth Century*.

LAST WORDS ABOUT AGNOSTICISM.

By HERBERT SPENCER.

THOSE who expected from Mr. Harrison an interesting rejoinder to my reply, will not be disappointed. Those who looked for points skilfully made, which either are, or seem to be, telling, will be fully satisfied. Those who sought pleasure from witnessing a display of literary power, will close his article gratified with the hour they have spent over it. Those only will be not altogether contented who supposed that my outspoken criticism of Mr. Harrison's statements and views, would excite him to an unusual display of that trenchant style for which he is famous; since he has, for the most part, continued the discussion with calmness. After saying thus much it may seem that some apology is needed for continuing a controversy of which many, if not most, readers, have by this time become weary. But gladly as I would leave the matter where it stands, alike to save my own time and others' attention, there are sundry motives which forbid me. Partly my excuse must be the profound importance and perennial interests of the questions raised. Partly I am prompted by the con-

sideration that it is a pity to cease just when a few more pages will make clear sundry of the issues, and leave readers in a better position for deciding. Partly it seems to me wrong to leave grave misunderstandings unrectified. And partly I am reluctant on personal grounds to pass by some of Mr. Harrison's statements unnoticed.

One of these statements, indeed, it would be imperative on me to notice, since it reflects on me in a serious way. Speaking of the "Descriptive Sociology," which contains a large part (though by no means all) of the evidence used in the "Principles of Sociology," and referring to the compilers who, under my superintendence, selected the materials forming that work, Mr. Harrison says :—

> Of course these intelligent gentlemen had little difficulty in clipping from hundreds of books about foreign races sentences which seem to support Mr. Spencer's doctrines. The whole proceeding is too much like that of a famous lawyer who wrote a law-book, and then gave it to his pupils to find the "cases" which supported his law.

Had Mr. Harrison observed the dates, he would have seen that since the compilation of the "Descriptive Sociology" was commenced in 1867 and the writing of the "Principles of Sociology" in 1874, the parallel he draws is not altogether applicable : the fact being that the "Descriptive Sociology" was commenced seven years in advance for the purpose (as stated in the preface) of obtaining adequate materials for generalizations : sundry of which, I may remark in passing, have been quite at variance with my pre-conceptions.* I think that on consideration, Mr. Harrison will regret having made so grave an insinuation without very good warrant ; and he has no warrant. Charity would almost lead one to suppose that he was not fully conscious of its implications when he wrote the above passage ; for he practically cancels them immediately afterwards. He says :—"But of course one can find in this medley of tables almost any view. And I find facts which make for my view as often as any other." How this last statement consists with the insinuation that what Mr. Harrison calls a "medley" of tables contains evidence vitiated by special selection of facts, it is difficult to understand. If the purpose was to justify a foregone conclusion, how does it happen that there are (according to Mr. Harrison) as many facts which make against it as there are facts which make for it ?

The question here incidentally raised concerns the primitive religious idea. Which is the original belief, fetichism or the ghost-theory ? The answer should profoundly interest all who care to under-

* Elsewhere Mr. Harrison contemptuously refers to the "Descriptive Sociology" as "a pile of clippings made to order." While I have been writing, the original directions to compilers have been found by my present secretary, Mr. James Bridge ; and he has drawn my attention to one of the "orders." It says that all works are "to be read not with a view to any particular class of facts but with a view to all classes of facts."

stand the course of human thought; and I shall therefore not apologize for pursuing the question a little further.

Having had them counted, I find that in those four parts of the "Descriptive Sociology" which give accounts of the uncivilized races, there are 697 extracts which refer to the ghost-theory: illustrating the belief in a wandering double which goes away during sleep, or fainting, or other form of insensibility, and deserts the body for a longer period at death,—a double which can enter into and possess other persons, causing disease, epilepsy, insanity, etc., which gives rise to ideas of spirits, demons, etc., and which originates propitiation and worship of ghosts. On the other hand there are 87 extracts which refer to the worship of inanimate objects or belief in their supernatural powers. Now even did these 87 extracts support Mr. Harrison's view, this ratio of 8 to 1 would hardly justify his statement that the facts "make for my [his] view as often as any other." But these 87 extracts do not make for his view. To get proof that the inanimate objects are worshipped for themselves simply, instances must be found in which such objects are worshipped among peoples who have no ghost-theory; for wherever the ghost-theory exists it comes into play and originates those supernatural powers which certain objects are supposed to have. When by unrelated tribes scattered all over the world, we find it held that the souls of the dead are supposed to haunt the neighboring forests—when we learn that the Karen thinks "the spirits of the departed dead crowd around him;" * that the Society Islanders imagined spirits "surrounded them night and day watching every action;" † that the Nicobar people annually compel "all the bad spirits to leave the dwelling;" ‡ that an Arab never throws anything away without asking forgiveness of the Efrits he may strike;" # and that the Jews thought it was because of the multitudes of spirits in synagogues that "the dress of the Rabbins become so soon old and torn through their rubbing;" ‖—when we find the accompanying belief to be that ghosts or spirits are capable of going into, and emerging from, solid bodies in general, as well as the bodies of the quick and the dead; it becomes obvious that the presence of one of these spirits swarming around, and capable of injuring or benefiting living persons, becomes a sufficient reason for propitiating an object it is assumed to have entered: the most trivial peculiarity sufficing to suggest possession—such possession being, indeed, in some cases conceived as universal, as by the Eskimo, who think every object is ruled by "its or his *inuk*, which word signifies '*man*,' and also *owner* or *in-*

* "Journal of Asiatic Society of Bengal," xxiv, part ii, p. 196.

† Ellis, "Polynesian Researches," vol. i, p. 525.

‡ "Journ. As. Soc. of Ben.," xv, pp. 348, 349.

\# Bastian, "Mensch," ii, 109, 113.

‖ "Supernatural Religion," 2d ed., vol. i, p. 112.

habitant." * Such being the case, there can be no proof that the worship of the objects themselves was primordial, unless it is found to exist where the ghost-theory has not arisen; and I know no instance showing that it does so. But while those facts given in the "Descriptive Sociology" which imply worship of inanimate objects, or ascription of supernatural powers to them, fail to support Mr. Harrison's view, because always accompanied by the ghost-theory, sundry of them directly negative his view. There is the fact that an echo is regarded as the voice of the fetich; there is the fact that the inhabiting spirit of the fetich is supposed to "enjoy the savory smell" of meat roasted before it; and there is the fact that the fetich is supposed to die and may be revived. Further, there is the summarized statement made by Beecham, an observer of fetichism in the region where it is supposed to be specially exemplified, who says that:—

> The fetiches are believed to be spiritual, intelligent beings, who make the remarkable objects of nature their residence, or enter occasionally into the images and other artificial representations, which have been duly consecrated by certain ceremonies. . . . They believe that these fetiches are of both sexes, and that they require food.

These statements are perfectly in harmony with the conclusion that fetichism is a development of the ghost-theory, and altogether incongruous with the interpretation of fetichism which Mr. Harrison accepts from Comte.

Already I have named the fact that Dr. Tylor, who has probably read more books about uncivilized peoples than any Englishman living or dead, has concluded that fetichism is a form of spirit-worship, and that (to give quotations relevant to the present issue)

> To class an object as a fetish, demands explicit statement that a spirit is considered as embodied in it or acting through it or communicating by it.†
>
> . . . A further stretch of imagination enables the lower races to associate the souls of the dead with mere objects.‡
>
> . . . The spirits which enter or otherwise attach themselves to objects may be human souls. Indeed, one of the most natural cases of the fetish-theory is when a soul inhabits or haunts the relics of its former body.#

Here I may add an opinion to like effect which Dr. Tylor quotes from the late Prof. Waitz, also an erudite anthropologist. He says:—

> According to his [the negro's] view, a spirit dwells or can dwell in every sensible object, and often a very great and mighty one in an insignificant thing. This spirit he does not consider as bound fast and unchangeably to the corporeal thing it dwells in, but it has only its usual or principal abode in it.‖

* Dr. Henry Rink, "Tales and Traditions of the Eskimo," p. 37.

† Tylor, "Primitive Culture," vol. ii, p. 133.

‡ Ibid., p. 139. # Ibid., p 137. ‖ Ibid., p. 144.

Space permitting I might add evidence furnished by Sir Alfred Lyall, who, in his valuable papers published in the "Fortnightly Review" years ago on religion in India, has given the results of observations made there. Writing to me from the North-West provinces under date August 1, in reference to the controversy between Mr. Harrison and myself, he incloses copies of a letter and accompanying memorandum from the magistrate of Gorakhpur, in verification of the doctrine that ghost-worship is the "chief source and origin" of religion. Not, indeed, that I should hope by additional evidence to convince Mr. Harrison. When I point to the high authority of Dr. Tylor as on the side of the ghost-theory, Mr. Harrison says—"If Dr. Tylor has finally adopted it, I am sorry." And now I suppose that when I cite these further high authorities on the same side, he will simply say again "I am sorry," and continue to believe as before.

In respect of the fetichism distinguishable as nature-worship, Mr. Harrison relies much on the Chinese. He says:—

> The case of China is decisive. There we have a religion of vast antiquity and extent, perfectly clear and well ascertained. It rests entirely on worship of Heaven, and Earth, and objects of Nature, regarded as organized beings, and not as the abode of human spirits.

Had I sought for a case of "a religion of vast antiquity and extent, perfectly clear and well ascertained," which illustrates origin from the ghost-theory, I should have chosen that of China; where the State-religion continues down to the present day to be an elaborate ancestor-worship, where each man's chief thought in life is to secure the due making of sacrifices to his ghost after death, and where the failure of a first wife to bear a son who shall make these sacrifices, is held a legitimate reason for taking a second. But Mr. Harrison would, I suppose, say that I had selected facts to fit my hypothesis. I therefore give him, instead, the testimony of a bystander. Count D'Alviella has published a *brochure* concerning these questions on which Mr. Harrison and I disagree.* In it he says on page 15:—

> La thèse de M. Harrison, au contraire,—que l'homme aurait commencé par l'adoration d'objets matériels "franchement regardés comme tels,"—nous paraît absolument contraire au raisonnement et à l'observation. Il cite, à titre d'exemple, l'antique religion de la Chine, "entièrement basée sur la vénération de la Terre, du Ciel et des Ancêtres, considérés objectivement et non comme la résidence d'êtres immatériels." [This sentence is from Mr. Harrison's first article, not from his second.] C'est là jouer de malheur, car, sans même insister sur ce que peuvent être des Ancêtres "considérés objectivement," il se trouve précisément que la religion de l'ancien empire Chinois est le type le plus parfait de l'animisme organisé et qu'elle regarde même les objets matériels, dont elle fait ses dieux, comme la manifestation inséparable, l'enveloppe ou même le corps d'esprits invisibles. [Here in a note Count D'Alviella refers to authorities,

* "Harrison contre Spencer sur la Valeur Religieuse de L'Inconnaissable," par le Cte. Goblet D'Alviella. Paris, Ernest Leroux.

"notamment Tiele, 'Manuel de l'Histoire des Religions,' traduit par M. Maurice Vernes, Liv. II, et dans la 'Revue de l'Histoire des Religions,' la 'Religion de l'ancien empire Chinois' par M. Julius Happel (t. IV, no. 6)."]

Whether Mr. Harrison's opinion is or is not changed by this array of counter-opinion, he may at any rate be led somewhat to qualify his original statement that "Nothing is more certain than that man everywhere started with a simple worship of natural objects."

I pass now to Mr. Harrison's endeavor to rebut my assertion that he had demolished a *simulacrum* and not the reality.

I pointed out that he had inverted my meaning by representing as negative that which I regarded as positive. What I have everywhere referred to as the All-Being, he named the All-Nothingness. What answer does he make when I show that my position is exactly the reverse of that alleged? He says that while I am "dealing with transcendental conceptions, intelligible only to certain trained metaphysicians," he is "dealing with religion as it affects the lives of men and women in the world;" that "to ordinary men and women, an unknowable and inconceivable Reality is practically an Unreality;" and that thus all he meant to say was that the "Everlasting Yes" of the "evolutionist," "is in effect on the public a mere Everlasting No" (p. 354). Now compare these passages in his last article with the following passages in his first article:—"One would like to know how much of the Evolutionist's day is consecrated to seeking the Unknowable in a devout way, and what the religious exercises might be. How does the man of science approach the All-Nothingness" (p. 502)? Thus we see that what was at first represented as the unfitness of the creed considered as offered to the select is now represented as its unfitness considered as offered to the masses. What were originally the "Evolutionist" and the "man of science" are now changed into "ordinary men and women" and "the public;" and what was originally called the All-Nothingness has become an "inconceivable Reality." The statement which was to be justified is not justified, but something else is justified in its stead.

Thus it is, too, with the paragraph in which Mr. Harrison seeks to disprove my assertion that he had exactly transposed the doctrines of Dean Mansel and myself, respecting our consciousness of that which transcends perception. He quotes his original words, which were, "there is a gulf which separates even his all-negative *deity* from Mr. Spencer's impersonal, unconscious, unthinkable Energy." And he then goes on to say: "I was speaking of Mansel's Theology, not of his Ontology. I said '*deity*,' not the Absolute." Very well; now let us see what this implies. Mansel, as I was perfectly well aware, supplements his ontological nihilism with a theological realism. That which in his ontological argument he represents as a mere "negation of conceivability," he subsequently reasserts on grounds of faith, and clothes

with the ordinarily ascribed divine attributes. Which of these did I suppose Mr. Harrison meant by "all-negative deity"? I was compelled to conclude he meant that which in the ontological argument was said to be a "negation of conceivability." How could I suppose that by "all-negative deity" Mr. Harrison meant the deity which Dean Mansel as a matter of "duty" rehabilitates and worships in his official capacity as priest? It was a considerable stretch of courage on the part of Mr. Harrison to call the deity of the established church an "all-negative deity." Yet in seeking to escape from the charge of misrepresenting me he inevitably does this by implication.

In his second article Mr. Harrison does not simply ascribe to me ideas which are wholly unlike those my words express, but he ascribes to me ideas I have intentionally excluded. When justifying my use of the word "proceed," as the most colorless word I could find to indicate the relation between the knowable manifestations present to perception and the Unknowable Reality which transcends perception, I incidentally mentioned, as showing that I wished to avoid those theological implications which Mr. Harrison said were suggested, that the words originally written were "created and sustained;" and that though in the sense in which I used them the meanings of these words did not exceed my thought, I had erased them because "the ideas associated with these words might mislead." Yet Mr. Harrison speaks of these erased words as though I had finally adopted them, and saddles me with the ordinary connotations. If Mr. Harrison defends himself by quoting my words to the effect that the Inscrutable Existence manifested through phenomena "stands towards our general conception of things in substantially the same relation as does the Creative Power asserted by Theology;" then I point to all my arguments as clearly meaning that when the attributes and the mode of operation ordinarily ascribed to "that which lies beyond the sphere of sense" cease to be ascribed, "that which lies beyond the sphere of sense" will bear the same relation as before to that which lies within it, in so far that it will occupy the same relative position in the totality of our consciousness: no assertion being made concerning the mode of connection of the one with the other. Surely when I had deliberately avoided the word "create" to express the connection between noumenal cause and the phenomenal effect, because it might suggest the ordinary idea of a creating power separate from the created thing, Mr. Harrison was not justified in basing arguments against me on the assumption that I had used it.

But the course in so many cases pursued by him of fathering upon me ideas incongruous with those I have expressed, and making me responsible for the resulting absurdities, is exhibited in the most extreme degree by the way in which he has built up for me a system of beliefs and practices. In his first article occur such passages as—"seeking the Unknowable in a devout way" (p. 502); can any one

"hope anything of the Unknowable or find consolation therein?" (p. 503); and to a grieving mother he represents me as replying to assuage her grief, "Think on the Unknowable" (p. 503). Similarly in his second article he writes, "to tell them that they are to worship this Unknowable is equivalent to telling them to worship nothing" (p. 357); "the worship of the Unknowable is abhorrent to every instinct of genuine religion" (p. 360); "praying to the Unknowable at home" (p. 376); and having in these and kindred ways fashioned for me the observances of a religion which he represents me as "proposing," he calls it "one of the most gigantic paradoxes in the history of thought" (p. 355). So effectually has Mr. Harrison impressed everybody by these expressions and assertions, that I read in a newspaper —"Mr. Spencer speaks of the 'absurdities of the Comtean religion,' but what about his own peculiar cult?"

Now the whole of this is a fabric framed out of Mr. Harrison's imaginations. I have nowhere "proposed" any "object of religion." I have nowhere suggested that any one should "worship this Unknowable." No line of mine gives ground for inquiring how the Unknowable is to be sought "in a devout way," or for asking what are "the religious exercises;" nor have I suggested that any one may find "consolation therein." Observe the facts. At the close of my article "Religion; a Retrospect and Prospect," I pointed out to "those who think that science is dissipating religious beliefs and sentiments," "that whatever of mystery is taken from the old interpretation is added to the new;" increase rather than diminution being the result. I said that in perpetually extending our knowledge of the Universe, concrete science "enlarges the sphere for religious sentiment;" and that progressing knowledge is "accompanied by an increasing capacity for wonder." And in my second article, in further explanation, I have represented my thesis to be "that whatever components of this [the religious] sentiment disappear, there must ever survive those which are appropriate to the consciousness of a Mystery that can not be fathomed and a Power that is omnipresent." This is the sole thing for which I am responsible. I have advocated nothing; I have proposed no worship; I have said nothing about "devotion," or "prayer," or "religious exercises," or "hope," or "consolation." I have simply affirmed the permanence of certain components in the consciousness which "is concerned with that which lies beyond the sphere of sense." If Mr. Harrison says that this surviving sentiment is inadequate for what he thinks the purposes of religion, I simply reply—I have said nothing about its adequacy or inadequacy. The assertion that the emotions of awe and wonder form but a fragment of religion, leaves me altogether unconcerned: I have said nothing to the contrary. If Mr. Harrison sees well to describe the emotions of awe and wonder as "some rags of religious sentiment surviving" (p. 358), it is not incumbent on me to disprove the fitness of his expression. I am respon-

sible for nothing whatever beyond the statement that these emotions will survive. If he shows this conclusion to be erroneous, then indeed he touches me. This, however, he does not attempt. Recognizing though he does that this is all I have asserted, and even exclaiming "is that all!" (p. 358), he nevertheless continues to father upon me a number of ideas quoted above, which I have neither expressed nor implied, and asks readers to observe how grotesque is the fabric formed of them.

I enter now on that portion of Mr. Harrison's last article to which is specially applicable its title "Agnostic Metaphysics." In this he recalls sundry of the insuperable difficulties set forth by Dean Mansel, in his "Bampton Lectures," as arising when we attempt to frame any conception of that which lies beyond the realm of sense. Accepting, as I did, Hamilton's general arguments which Mansel applied to theological conceptions, I contended in "First Principles" that their arguments are valid, only on condition that that which transcends the relative is regarded not as negative, but as positive; and that the relative itself becomes unthinkable as such in the absence of a postulated non-relative. Criticisms on my reasoning allied to those made by Mr. Harrison, have been made before, and have before been answered by me. To an able metaphysician, the Rev. James Martineau, I made a reply which I may be excused here for reproducing, as I can not improve upon it:

Always implying terms in relation, thought implies that both terms shall be more or less defined; and as fast as one of them becomes indefinite, the relation also becomes indefinite, and thought becomes indistinct. Take the case of magnitudes. I think of an inch; I think of a foot; and having tolerably definite ideas of the two, I have a tolerably definite idea of the relation between them. I substitute for the foot a mile; and being able to represent a mile much less definitely, I can not so definitely think of the relation between an inch and a mile—can not distinguish it in thought from the relation between an inch and two miles, as clearly as I can distinguish in thought the relation between an inch and one foot from the relation between an inch and two feet. And now if I endeavor to think of the relation between an inch and the 240,000 miles from here to the Moon, or the relation between an inch and the 92,000,000 miles from here to the Sun, I find that while these distances, practically inconceivable, have become little more than numbers to which I frame no answering ideas, so, too, has the relation between an inch and either of them become practically inconceivable. Now this partial failure in the process of forming thought-relations, which happens even with finite magnitudes when one of them is immense, passes into complete failure when one of them can not be brought within any limits. The relation itself becomes unrepresentable at the same time that one of its terms becomes unrepresentable. Nevertheless, in this case it is to be observed that the almost-blank form of relation preserves a certain qualitative character. It is still distinguishable as belonging to the consciousness of extensions, not to the consciousnesses of forces or durations; and in so far remains a vaguely-identifiable relation. But now suppose we ask what happens when one term of the

relation has not simply magnitude having no known limits, and duration of which neither beginning nor end is cognizable, but is also an existence not to be defined? In other words, what must happen if one term of the relation is not only quantitatively but also qualitatively unrepresentable? Clearly in this case the relation does not simply cease to be thinkable except as a relation of a certain class, but it lapses completely. When one of the terms becomes wholly unknowable, the law of thought can no longer be conformed to; both because one term can not be present, and because relation itself can not be framed. . . . In brief, then, to Mr. Martineau's objection I reply, that the insoluble difficulties he indicates arise here, as elsewhere, when thought is applied to that which transcends the sphere of thought; and that just as when we try to pass beyond phenomenal manifestations to the Ultimate Reality manifested, we have to symbolize it out of such materials as the phenomenal manifestations give us; so we have simultaneously to symbolize the connection between this Ultimate Reality and its manifestations, as somehow allied to the connections among the phenomenal manifestations themselves. The truth Mr. Martineau's criticism adumbrates, is that the law of thought fails where the elements of thought fail; and this is a conclusion quite conformable to the general view I defend. Still holding the validity of my argument against Hamilton and Mansel, that in pursuance of their own principle the Relative is not at all thinkable *as such*, unless in contradistinction to some existence posited, however vaguely, as the other term of a relation, conceived however indefinitely; it is consistent on my part to hold that in this effort which thought inevitably makes to pass beyond its sphere, not only does the product of thought become a dim symbol of a product, but the process of thought becomes a dim symbol of a process; and hence any predicament inferable from the law of thought can not be asserted.*

Thus then criticisms like this of Mr. Martineau, often recurring in one shape or other, and now again made by Mr. Harrison, do not show the invalidity of my argument, but once more show the imbecility of human intelligence when brought to bear on the ultimate question. Phenomenon without noumenon is unthinkable; and yet noumenon can not be thought of in the true sense of thinking. We are at once obliged to be conscious of a reality behind appearance, and yet can neither bring this consciousness of reality into any shape, nor can bring into any shape its connection with appearance. The forms of our thought, moulded on experiences of phenomena, as well as the connotations of our words formed to express the relations of phenomena, involve us in contradictions when we try to think of that which is beyond phenomena; and yet the existence of that which is beyond phenomena is a necessary datum alike of our thoughts and our words. We have no choice but to accept a formless consciousness of the inscrutable.

I can not treat with fulness the many remaining issues. To Mr. Harrison's statement that it was uncandid in me to implicate him with the absurdities of the Comtean belief and ritual, notwithstanding his public utterances, I reply that whereas ten years ago I was led to think he gave but a qualified adhesion to Comte's religious doctrine, such

* "Essays," vol. iii, pp. 293–296.

public utterances of his as I have read of late years, fervid in their eloquence, persuaded me that he had become a much warmer adherent. On his summary mode of dealing with my criticism of the Comtean creed some comment is called for. He remarks that there are "good reasons for declining to discuss with Mr. Spencer the writings of Comte;" and names, as the first, "that he knows [I know] nothing whatever about them" (p. 365). Now as Mr. Harrison is fully aware that thirty years ago I reviewed the English version of those parts of the Positive Philosophy which treat of Mathematics, Astronomy and Physics; and as he has referred to the pamphlet in which, ten years later, I quoted a number of passages from the original to signalize my grounds of dissent from Comte's system; I am somewhat surprised by this statement, and by the still more emphatic statement that to me "the writings of Comte are, if not the Absolute Unknowable, at any rate the Absolute Unknown" (p. 365). Doubtless these assertions are effective; but like many effective assertions they do not sufficiently recognize the facts. The remaining statements in this division of Mr. Harrison's argument, I pass over: not because answers equally adequate with those I have thus far given do not exist, but because I can not give them without entering upon personal questions which I prefer to avoid.

On the closing part of "Agnostic Metaphysics" containing Mr. Harrison's own version of the Religion of Humanity, I have to remark, as I find others remarking, that it amounts, if not to an abandonment of his original position, still to an entire change of front. Anxious, as he has professed himself, to retain the "magnificent word Religion" (p. 504), it now appears that when "the Religion of Humanity" is spoken of, the usual connotations of the word are to be in large measure dropped: to give it these connotations is "to foist in theological ideas where none are suggested by us" (p. 369). While, in his first article, one of the objections raised to the "neo-theisms" as well as "the Unknowable," was that there is offered "no relation whatever between worshipper and worshipped" (p. 505) (an objection tacitly implying that Mr. Harrison's religion supplies this relation), it now appears that Humanity is not to be worshipped in any ordinary sense; but that by worship is simply meant "intelligent love and respect for our human brotherhood," and that "in plain words, the Religion of Humanity means recognizing your duty to your fellow-man on human grounds" (p. 369). Certainly this is much less than what I and others supposed to be included in Mr. Harrison's version of the Religion of Humanity. If he preaches nothing more than an ecstatic philanthropy, few will object; but most will say that his name for it conveyed to them a much wider meaning. Passing over all this, however, I am concerned chiefly to point out another extreme misrepresentation made by Mr. Harrison when discussing my criticism of Comte's assertion that "veneration and gratitude" are due to the

Great Being Humanity. After showing why I conceive "veneration and gratitude" are not due to Humanity, I supposed an opponent to exclaim (putting the passage within quotation-marks), "But surely 'veneration and gratitude' are due somewhere," since civilized society with all its products "must be credited to some agency or other." [This apostrophe, imagined as coming from a disciple of Comte, Mr. Harrison, on p. 373, actually represents as made in my own person!] To this apostrophe I have replied (p. 22) that "if 'veneration and gratitude' are due at all, they are due to that Ultimate Cause from which Humanity, individually and as a whole, in common with all other things has proceeded." Whereupon Mr. Harrison changes my hypothetical statement into an actual statement. He drops the "*if*," and represents me as positively affirming that "veneration and gratitude" are due somewhere: saying that Mr. Spencer "lavishes his 'veneration and gratitude,' called out by the sum of human civilization, upon his Unknowable and Inconceivable Postulate" (p. 373). I should have thought that even the most ordinary reader, much more Mr. Harrison, would have seen that the argument is entirely an argument *ad hominem*. I deliberately and carefully guarded myself by the "*if*" against the ascription to me of any opinion, one way or the other: being perfectly conscious that much is to be said for and against. The optimist will unhesitatingly affirm that veneration and gratitude are due; while by the pessimist it will be contended that they are not due. One who dwells exclusively on what Emerson calls "the saccharine" principle in things, as illustrated for example in the adaptation of living beings to their conditions—the becoming callous to pains that have to be borne, and the acquirement of liking for labors that are necessary—may think there are good reasons for veneration and gratitude. Contrariwise, these sentiments may be thought inappropriate by one who contemplates the fact that there are some thirty species of parasites which prey upon man, possessing elaborate appliances for maintaining their hold on or within his body, and having enormous degrees of fertility proportionate to the small individual chances their germs have of getting into him and torturing him. Either view may be supported by masses of evidence; and knowing this I studiously avoided complicating the issue by taking either side. As any one may see who refers back, my sole purpose was that of showing the absurdity of thinking that "veneration and gratitude" are due to the product and not to the producer. Yet Mr. Harrison, having changed my proposition "*if* they are due, etc.," into the proposition "they are due, etc.," laughs over the contradictions in my views which he deduces, and to which he time after time recurs, commenting on my "astonishing perversity."

In this division of Mr. Harrison's article occur five other cases in which, after his manner, propositions are made to appear untenable or ludicrous; though any one who refers to them as expressed by me will

find them neither the one nor the other. But to show all this would take much trouble to small purpose. Indeed, I must here close the discussion, so far as my own desistence enables me. It is a wearisome and profitless business, this of continually going back on the record, now to show that the ideas ascribed to me are not the ideas I expressed, and now to show that the statements my opponent defends are not the statements he originally made. A controversy always opens side issues. Each new issue becomes the parent of further ones. The original questions become obscured in a swarm of collateral questions; and energies, in my case ill-spared, are wasted to little purpose.

Before closing, however, let me again point out that nothing has been said which calls for change of the views expressed in my first article.

Setting out with the statement that "unlike the ordinary consciousness, the religious consciousness is concerned with that which lies beyond the sphere of sense," I went on to show that the rise of this consciousness begins among primitive men with the belief in a double belonging to each individual, which, capable of wandering away from him during life, becomes his ghost or spirit after death; and that from this idea of a being eventually distinguished as supernatural, there develop, in course of time, the ideas of supernatural beings of all orders up to the highest. Mr. Harrison has alleged that the primitive religion is not belief in, and propitiation of, the ghost, but is worship of "physical objects treated frankly as physical objects" (p. 498). That he has disproved the one view and proved the other, no one will, I think, assert. Contrariwise, he has given occasion for me to cite weighty authorities against him.

Next it was contended that in the assemblage of supernatural beings thus originating in each tribe, some, derived from chiefs, were superior to others; and that, as the compounding and re-compounding of tribes gave origin to societies having social grades and rulers of different orders, there resulted that conception of a hierarchy of ghosts or gods which polytheism shows us. Further it was argued that while, with the growth of civilization and knowledge, the minor supernatural agents became merged in the major supernatural agent, this single great supernatural agent, gradually losing the anthropomorphic attributes at first ascribed, has come in our days to retain but few of them; and, eventually losing these, will then merge into a consciousness of an omnipresent power to which no attributes can be ascribed. This proposition has not been contested.

In pursuance of the belief that the religious consciousness naturally arising, and thus gradually transformed, would not disappear wholly, but that "however much changed it must continue to exist," it was argued that the sentiments which had grown up around the conception of a personal God, though modified when that conception was modi-

fied into the conception of a power which can not be known or conceived, would not be destroyed. It was held that there would survive, and might even increase, the sentiments of wonder and awe in presence of a universe of which the origin and nature, meaning and destiny, can neither be known nor imagined ; or that, to quote a statement afterwards employed, there must survive those emotions "which are appropriate to the consciousness of a mystery that can not be fathomed and a power that is omnipresent." This proposition has not been disproved ; nor, indeed, has any attempt been made to disprove it.

Instead of assaults on these propositions to which alone I am committed, there have been assaults on various propositions gratuitously attached to them ; and then the incongruities evolved have been represented as incongruities for which I am responsible.

I end by pointing out as I pointed out before, that "while the things I have said have not been disproved, the things which have been disproved are things I have not said."—*Nineteenth Century.*

INFLUENCES DETERMINING SEX.*

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Of the many writers upon this subject, some have approached it with such an imperfect and narrow acquaintance with the facts that their contributions are of no interest to the scientific student ; while other writers have allowed some minor generalizations to assume such prominence that their papers are of little value in themselves. The subject has an especial fascination for many minds, apart from its very great scientific interest, and we can, therefore, understand that the fugitive literature is somewhat in disrepute among students.

In Düring's papers, however, we find a remarkable combination of the two elements of scientific research : thorough observation and accumulation of evidence, and reflection upon its hidden significance. Although they contain comparatively little original observation, they are remarkable for the encyclopedic information which the author has collected from all sources. In many cases his generalizations are based upon observations which run up into the millions, and, even where the reader is not prepared to accept his conclusions, he will find in the papers a mine of recorded facts.

Having shown that there is in each species of animals or plants a

* "On the Laws which determine the Sex of the Embryo in Mankind, in Animals, and in Plants." Carl Düring, "Jenaische Zeitschrift," xvi, iii, 1883, p. 428 ; and xvii, 1884, pp. 592–940.

constant average ratio between the sexes adapted to the conditions of life, he gives his reasons for believing that this ratio is not determined by any inner law, but by the influence of external conditions, which act sometimes upon the parent organism, sometimes upon the egg before fertilization, sometimes upon the developing egg or embryo, and sometimes, as in the case of many plants, upon the mature organism. He also believes that the character of the influence thus exerted by external conditions has been determined for the good of each species —by natural selection.

He treats, in the first part of his paper, of those conditions which act upon the two parents in opposite ways, and he summarizes his conclusions as follows: "*Each species has acquired, through natural selection, the useful property, in virtue of which any deviation from the average ratio between the sexes is corrected by an increased number of births of the deficient sex, or a decreased number of births of the sex which is in excess.*"

We have space for only two of the many illustrations which he quotes to prove the existence of this law, and for further proof must refer the reader to the long tables of statistics in the original paper.

As the result of nearly a million observations of the birth of colts, he shows that, as the number of mares put to a stallion in a year is increased, there is a corresponding and regular increase in the number of male colts as compared with the female colts, and he gives the following summary:

Number of mares to one stallion.	Number of colts.		Number of male to each one hundred female colts.
	Male.	Female.	
20 to 34	29,023	29,934	96·94
35 to 39	44,911	46,493	96·60
40 to 44	66,573	69,045	96·42
45 to 49	69,774	72,073	96·81
50 to 54	69,972	71,461	97·92
55 to 59	75,493	74,912	100·77
60 or more	71,407	70,569	101·19
Total	427,153	434,487	98·31

In three cases where the power of parthenogenetic reproduction has been acquired as a compensation for the absence of males, the parthenogenetic eggs give rise either universally, or in the vast majority of cases, to males.

For instance, as bees destroy the males after they have been rendered unnecessary by the fertilization of the queen, they are exposed to the danger that when males are needed none may exist, and there can be no doubt that the power of parthenogenetic reproduction has been acquired by bees as a compensating adjustment.

When the nuptial flight of the queen is delayed by accident, or by the intervention of the breeder, the effect is, of course, equivalent

to a scarcity of males, and in such a case more male larvæ than usual are produced; while early fertilization, which is a sign of the abundance of males, results, according to Huber, in an excess of female births.

Any influence which is equivalent to a lack of individuals of one sex acts, according to Düring, to produce an excess of births of that sex, although there may be an actual deficiency.

Thus, when the queen-bee is restrained by confinement, or by the lack of wings, from the nuptial flight, or when the seminal receptacle has been removed by accident or by an operation, or when the contained semen has been killed by frost or exhausted, only males are produced.

Something of the same kind has been observed in man, and the fact that a war, which carries most of the men away from their homes, is followed by an unusually great number of male births, has been recorded by many observers.

The second part of the paper, which will be found by far the most interesting to the scientific student, treats of those influences which act in the same way upon both parents, and the author's conclusion may be summarized as follows:

The power to regulate fertility according to the means of subsistence would be of use to the organism, and since the female has gradually acquired, through division of labor, the function of providing the material for the growth of the young, an excess of females is a condition of rapid multiplication. We might therefore expect, what we actually find to be the case, that organisms have gradually acquired, through natural selection, the power to produce an excess of females in time of plenty, and in a season of scarcity of food an excess of males.

I think, however, that careful examination of the evidence which Düring has brought together will show that he has stated his generalization in too narrow terms, and I think his facts will prove the following: *A favorable environment causes an excess of female births, and an unfavorable environment an excess of male births.*

It is true that abundance or scarcity of food is one of the most important elements of that whole which makes up the *environment* of an organism, and in most of the cases which Düring quotes it is the controlling factor; but he gives many cases, some of which will be noted further on, where a variation in other conditions of life has produced the same effect, causing an excess of male births when unfavorable, and an excess of female births when favorable.

In the case of man, the conditions of life are so much under control that it is difficult to state just what constitutes a favorable environment, but I think we may conclude that, as a general rule, an environment which produces a high birth-rate is favorable, and *vice versa.* Now, Düring gives many tables to show that, among mankind, the

number of female births, as compared with the number of male births, increases as the birth-rate increases.

At the Cape of Good Hope the Boers are very prolific—six or seven is a small family, and from twelve to twenty children are not unusual; while the badly nourished and overworked Hottentots seldom have more than three children, and many of the women are barren, and Quetelet says that in 1813–'20 the free whites gave birth to 6,604 boys and 6,789 girls, or 97·2 boys to every 100 girls; while during the same time the Hottentot slaves produced 2,936 boys and 2,826 girls, or 103·9 boys to each 100 girls.

The birth-rate is higher in towns than in the country, and more boys are born for each hundred girls in the country than in the towns. Thus, in Prussia, in 1881, the number of boy-births for each 100 girls was 106·36.

In Berlin it was	105·70
In large towns it was	105·72
In middle towns it was	105·44
In small towns it was	106·14
In the country it was	106·62

This table shows that in all the towns the ratio of boys was below the average for the whole of Prussia, and that in Berlin it was very much below the average.

Ploss was the first to point out that there is an excess of female births in time of prosperity, and he found that in Saxony the ratio of boy-births rose and fell with the price of food, and that the variation was most marked in the country.

It is well known that the number of conceptions among mankind is greater at some seasons of the year than at others, and from a record of nearly 10,000,000 births Düring has compiled the following table, which shows that the ratio of boy-births is greatest in three months when the birth-rate is smallest:

Conception. Birth.	April. January.	May. February.	June. March.	July. April.	August. May.	September. June.	October. July.
Boys	484,443	451,750	484,786	450,272	446,642	419,541	439,685
Girls	455,847	425,091	457,702	424,740	420,867	392,928	411,888
Total	940,290	876,841	942,488	875,012	867,509	812,469	851,573
Ratio	106·27	106·27	105·92	106·01	106·02	106·77	106·75

Conception. Birth.	November. August.	December. September.	January. October.	February. November.	March, December.	Whole year.
Boys	458,385	479,023	468,337	452,894	464,024	5,499,782
Girls	431,192	452,045	440,447	426,343	435,382	5,174,472
Total	889,577	931,068	908,784	879,237	899,404	10,678,254
Ratio	106·31	105·97	106·33	106·23	106·58	106·287

From this table it will be seen that in June, the month when the birth-rate was smallest, the ratio of boys to each 100 girls was highest, and very much above the average for the whole year ; while in March, the month when the birth-rate was greatest, the ratio of boys was smallest.

More than 6,000,000 births took place in the seven months when the ratio of boys was below the average for the year, and only 4,000,000 in the five months when it was above the average ; and the table shows clearly that an increase in prosperity, as measured by the birth-rate, is accompanied by a decrease in the ratio of boy-births, and *vice versa.*

Among the lower animals, satisfactory statistics are wanting ; but Düring states that, while domesticated animals are much more prolific than their wild allies, there is also a much greater preponderance of female births ; that when animals are taken from a warm to a cold climate, the ratio of male births increases ; and that leather-dealers say that they obtain most female skins from fertile countries where the pastures are rich, and most male skins from more barren regions; and he thinks we may safely conclude that the lower animals, as well as man, give birth to the greatest number of females when placed in a favorable environment, and to most males in an unfavorable environment.

An extreme instance is furnished by those animals which, during the seasons when food is abundant, lose the power to copulate and multiply parthenogenetically at a marvelous rate of increase, giving birth to generation after generation of parthenogenetic females, so long as the environment remains favorable, but giving birth, as soon as the conditions of life become less favorable, to males and to females which require fertilization.

The cladocera and aphides furnish the most striking instances of this kind of parthenogenesis, which has apparently been acquired, not to secure fertilization, but to enable the animals to utilize to the utmost the conditions which are most favorable to them, and to expand and contract their numbers in conformity to changes in their environment.

Among the parthenogenetic cladoceras both males and females are to be found in the fall, and a few males are found in the early spring ; but during the warm months of spring and summer only females are found. These multiply very rapidly through the summer by parthenogenesis, generation after generation, and they differ from the females which are fertilized by a male in many features, all of which are of such a character as to render the parthenogenetic females unusually fertile.

They produce small eggs, which are discharged from the ovary while immature, and are nourished in a vascular broad pouch. They have little or no yolk ; they are not protected by a hard shell, and they develop immediately into parthenogenetic females, which mature

very rapidly, and in some cases, as in evadne, produce eggs before they themselves are born. All their peculiarities are of such a character as to secure the greatest possible fertility; and thus to enable the animals to avail themselves, to the utmost, of the abundant supply of food.

Ramdohr found that a single isolated female daphnia produced 190 young in nineteen days, and he computed the number of descendents, at the end of sixty days, to be 1,291,370,075.

As the supply of food begins to fail in the fall, males are born, and the females produce the so-called *winter eggs*, which do not develop unless they are fertilized. These are few in numbers, much larger than the summer eggs, and they are incased in protecting shells. Their purpose is not to multiply the race, but to carry a few individuals through the winter, and over to the next season of plenty. They are slowly matured in the ovary, and contain an abundant supply of food-yolk. They are not nourished in a broad chamber, and in many cases they have, in addition to the proper shell, an extra covering or ephipium, formed out of part of the integument of the parent. In daphnella three summer eggs are matured, at one time, in each ovary; but the animal produces only one winter egg, which is seven tenths as long as the whole body.

While the abundance or lack of food is a very important factor in determining the absence or presence of males, it is not the only one. Kurg found a few males in mid summer, but only in pools which were nearly dried up; and he was thus induced to attempt the artificial production of males. He was so successful that he obtained the males of forty species, in all of which the males had previously been unknown. He proved that any unfavorable change in the water causes the production of males, which appear as it dries up, as its chemical constitution changes, when it acquires an unfavorable temperature, or in general when there is a decrease in prosperity.

From these observations and from many others quoted by Düring, I think we may safely conclude that among animals and plants, as well as in mankind, *a favorable environment causes an excess of female births, and an unfavorable environment an excess of male births.*

Now, what is the reason for this law? If the welfare of the species can be secured, under a favorable environment, by females alone, why are males needed when the environment becomes unfavorable?

I have tried to show, in another place, from evidence of another kind, that the female is the conservative factor in reproduction, and that new variations are caused by the influence of the male. While the environment remains favorable no change is needed, but, as the conditions of life become unfavorable, variation becomes necessary to restore the adjustment, and I believe that we have, in Düring's results, an exhibition of one of the most wonderful and far-reaching of all the adaptations of Nature—an adaptation in virtue of which each organ-

ism tends to remain stationary as long as no change is needed, and to vary when variation is demanded.

That this is the true view is shown, I think, by the contrast between domesticated animals and captive animals. The fact that an animal has become domesticated shows that it finds in captivity a favorable environment, and Düring says that domesticated animals are unusually fertile, and that they produce an excess of females. Animals which are kept as captives in menageries and gardens have, as a rule, no fitness for domestication, and their conditions of life are unfavorable. Geoffroy Saint-Hilaire says that individuals born in menageries are usually male, while skins sent to museums are usually female, and that the attempt to domesticate a wild animal increases the number of male births. Düring states that captive birds of prey and carnivorous mammals are very infertile, and that the young are nearly always males.

The wild races of Oceania and America have been suddenly brought into contact with the civilization which has been, in Europe, the slow growth of thousands of years. Food and climate have not changed, but a new element has been introduced into their environment. The New-Zealanders are very infertile, and nearly all the children are boys, and the census of 1872 for the Sandwich Islands gave a ration of 125 male births to 100 female births.

I believe that we may see, in these instances, the last effort of Nature to save the race from extinction, by securing a favorable variation.

It is no more than right, however, to point out that Düring himself gives a different explanation, and attributes the excess of male births under unfavorable conditions to the need for preventing close interbreeding. He shows that close interbreeding causes sterility, small size, and lack of general vigor and vitality ; and he also shows that these effects are most marked when the other conditions of life are unfavorable, and that no evil effect follows close interbreeding when food is very abundant and the environment in general conducive to prosperity. As the evil effects of interbreeding are most marked when the environment is unfavorable, and as male births are then in excess, he believes that the excessive production of males is an adaptation, which has been gradually acquired for the purpose of preventing close interbreeding at the time when it is injurious.

I believe that a little examination will show that this explanation is imperfect, although true in a certain sense. As natural selection can not act in such a way as to establish an injurious property, the evil effects of interbreeding can not be primary. The thing which is advantageous and which has been secured by natural selection is crossing, or the sexual union of organisms which are not closely related.

As the object of crossing is to secure variability, it is most necessary when variation is needed, that is, when the conditions of life are unfavorable.

Natural selection has accordingly acted to secure this, by rendering the offspring of a cross more able to resist an unfavorable change in the conditions of life than the offspring of closely related parents or the parthenogenetic children of unfertilized females, and the excessive birth of males, under unfavorable conditions, is for the purpose of securing variation, rather than the prevention of interbreeding.

In conclusion, I wish to again call the attention of the reader to Düring's papers, as they are filled with interesting reflections and suggestive observations which have received no notice in this short review.

They not only contain a treasury of facts, but they also show that in many parts of the field there is a great lack of recorded observations, and as some of our readers may be able to contribute something toward filling these gaps, and thus to extend our knowledge of the subject, the writer of this review takes this occasion to ask all who have made any observations upon the number of male and female births of wild or domesticated animals to make their results known. If they are sent to him, he will take pleasure in tabulating them, and will give proper credit for them.

MY SCHOOLS AND SCHOOLMASTERS.*

By Professor TYNDALL.

OUR lives are interwoven here below, frequently, indeed most frequently, without our knowing it. We are in great part molded by unconscious interaction. Thus, without intending it, the present representative of the Birkbeck family in Yorkshire has helped to shape my life. In 1856, or thereabout, Mr. John Birkbeck aided in founding on the slope of a Swiss mountain the Æggischhorn Hotel. The success of this experiment provoked in the neighboring commune a spirit of rivalry and imitation, and accordingly upon a bold bluff overlooking the Great Aletsch glacier was subsequently planted the Bel Alp Hotel. To the Bel Alp I went in my wanderings. Seeing it often, I liked it well, until at length the thought dawned upon me of building a permanent nest there. Before doing so, however, I imitated the birds, chose and was chosen by a mate who, like myself, loved the freedom of the mountains, and we built our nest together. From that nest I have come straight to the Birkbeck Institution, so that the following chain of connection stretches between Mr. John Birkbeck and me: Without him there would have been no Æggischhorn; without the Æggischhorn there would have been no Bel Alp; without Bel Alp there would have been no Tyndall's nest, and without that nest the person who now

* An address delivered at the Birkbeck Institution, Wednesday, October 22, 1884.

addresses you would undoubtedly be a different man from what he is. His bone would have been different bone ; his flesh different flesh—nay, the very gray matter of his brain, which is said to be concerned in the production of thought, would have been different from what it now is. I wrote to Mr. Norris from the Alps asking him to choose between a purely scientific lecture and an address based on the experiences of my own life. He chose the latter. I do not, however, ask you to blame Mr. Norris, but to blame me, if a chapter from the personal history of a worker, instead of proving a stimulus and an aid, should seem to you flat, stale, and unprofitable. . . . Speaking of the opportune beneficence of Dr. Birkbeck's movement reminds me that, in the days of my youth, personally and directly, I derived profit from that movement. In 1842 and thereabout it was my privilege to be a member of the Preston Mechanics' Institution—to attend its lectures and make use of its library. One experiment made in these lectures I have never forgotten—Surgeon Corless, I think it was, who lectured on respiration, explaining, among other things, the changes produced by the passage of air through the lungs. What went in as free oxygen came out bound up in carbonic acid. To prove this he took a flask of lime-water, and, by means of a glass tube dipped into it, forced his breath through the water. The carbonic acid from the lungs seized upon the dissolved lime, converting it into carbonate of lime, which, being practically insoluble, was precipitated. All this was predicted beforehand by the lecturer, but the delight with which I saw his prediction fulfilled, by the conversion of the limpid lime-water into a turbid mixture of chalk and water, remains with me, as a memory, to the present hour. The students of the Birkbeck Institution may therefore grant me the honor of ranking myself among them as a fellow-student of a former generation. At the invitation of an officer of the Royal Engineers, who afterward became one of my most esteemed and intimate friends, I quitted school in 1839 to join a division of the Ordinance Survey. The profession of a civil engineer having then great attractions for me, I joined the survey, intending, if possible, to make myself master of all its operations, as a first step toward becoming a civil engineer. Draughtsmen were the best paid, and I became a draughtsman. But I habitually made incursions into the domains of the calculator and computer, and thus learned all their art. In due time the desire to make myself master of field operations caused me to apply for permission to go to the field. The permission was granted by my excellent friend General George Wynne, who then, as Lieutenant Wynne, observed and did all he could to promote my desire for improvement. Before returning to the office I had mastered all the mysteries of ordinary field-work, and by a fortunate opportunity, and with the sound knowledge of elementary geometry and trigonometry which I had acquired before leaving school, was enabled successfully to make some trigonometrical observations, though there had been bets against me. The pay upon the Ordinance Survey

was very small, but, having ulterior objects in view, I considered the instruction received as some set-off to the smallness of the pay. It might prevent some of you young Birkbeckians from considering your fate specially hard, or from being daunted, because from a very low level you have to climb a very steep hill, when I tell you that, on quitting the Ordinance Survey in 1843, my salary was a little under twenty shillings a week. I have often wondered since at the amount of genuine happiness which a young fellow, of regular habits, not caring for either pipe or mug, may extract even from pay like that. Then came a pause, and after it the mad time of the railway mania, when I was able to turn to account the knowledge I had gained upon the Ordinance Survey. In Staffordshire, Cheshire, Lancashire, Durham, and Yorkshire, more especially in the last, I was in the thick of the fray. It was a time of terrible toil. The day's work in the field usually began and ended with the day's light, while frequently in the office, and more especially as the awful 30th of November—the latest date at which plans and sections of projected lines could be deposited at the Board of Trade—drew near, there was little difference between day and night, every hour of the twenty-four being absorbed in the work of preparation. Strong men were broken down by the strain and labor of that arduous time. Many pushed through, and are still among us in robust vigor; but some collapsed, while others retired with large fortunes, but with intellects so shattered that, instead of taking their places in the front rank of English statesmen, as their abilities entitled them to do, they sought rest for their brains in the quiet lives of country gentlemen. In my own modest sphere I well remember the refreshment I occasionally derived from five minutes' sleep on a deal table, with "Babbage and Callet's Logarithms" under my head for a pillow. On a certain day, under grave penalties, certain levels had to be finished, and this particular day was one of agony to me. The atmosphere seemed filled with mocking demons, laughing at the vanity of my efforts to get the work done. My leveling staves were snapped, and my theodolite was overthrown by the storm. When things are at their worst a kind of anger often takes the place of fear. It was so in the present instance: I pushed doggedly on, and just at nightfall, when barely able to read the figures on my leveling-staff, I planted my last "bench-mark" on a tombstone in Haworth churchyard. Close at hand was the vicarage of Mr. Brontë, where the genius was nursed which soon afterward burst forth and astonished the world. It was a time of mad unrest—of downright monomania. In private residences and public halls, in London reception-rooms, in hotels and the stables of hotels, among gypsies and costermongers, nothing was spoken of but the state of the share-market, the prospects of projected lines, the good fortune of the ostler or pot-boy who by a lucky stroke of business had cleared ten thousand pounds. High and low, rich and poor, joined in the reckless game. During my professional connection with

railways I endured three weeks' misery. It was not defeated ambition; it was not a rejected suit; it was not the hardship endured in either office or field; but it was the possession of certain shares purchased in one of the lines then afloat. The share list of the day proved the winding-sheet of my peace of mind. I was haunted by the Stock Exchange. I became at last so savage with myself that I went to my brokers and put away, without gain or loss, the shares as an accursed thing. When railway work slackened I accepted, in 1847, a post as a master in Queenwood College, Hampshire—an establishment which is still conducted with success by a worthy principal. There I had the pleasure of meeting Dr. Franklin, who had charge of the chemical laboratory. Queenwood College had been the Harmony Hall of the Socialists, which, under the auspices of the philanthropist Robert Owen, was built to inaugurate the millennium. The letters "C of M," Commencement of Millennium, were actually inserted in flint in the brick-work of the house. Schemes like Harmony Hall look admirable upon paper; but, inasmuch as they are formed with reference to an ideal humanity, they go to pieces when brought into collision with the real one. At Queenwood, I learned, by practical experience, that two factors went to the formation of a teacher. In regard to knowledge he must, of course, be master of his work. But knowledge is not all. There may be knowledge without power—the ability to inform, without the ability to stimulate. Both go together in the true teacher. A power of character must underlie and enforce the work of the intellect. There are men who can so rouse and energize their pupils—so call forth their strength and the pleasure of its exercise—as to make the hardest work agreeable. Without this power it is questionable whether the teacher can ever really enjoy his vocation—with it I do not know a higher, nobler, more blessed calling than that of the man who, scorning the "cramming" so prevalent in our day, converts the knowledge he imparts into a lever, to lift, exercise, and strengthen the growing minds committed to his care. At the time here referred to I had emerged from some years of hard labor the fortunate possessor of two or three hundred pounds. By selling my services in the dearest market during the railway madness the sum might, without dishonor, have been made a larger one; but I respected ties which existed prior to the time when offers became lavish and temptation strong. I did not put my money in a napkin, but cherished the design of spending it in study at a German university. I had heard of German science, while Carlyle's references to German philosophy and literature caused me to regard them as a kind cf revelation from the gods. Accordingly, in the autumn of 1848, Frankland and I started for the land of universities, as Germany is often called. They are sown broadcast over the country, and can justly claim to be the source of an important portion of Germany's present greatness. A portion, but not all. The thews and sinews of German men were not given by German universities. The

steady fortitude and valiant laboriousness which have fought against, and triumphed over, the gravest natural disadvantages, are not the result of university culture. But the strength and endurance which belong to the German, as a gift of race, needed enlightenment to direct it; and this was given by the universities. Into these establishments was poured that sturdy power which in other fields had made the wastes of Nature fruitful, and the strong and earnest character had thus superimposed upon it the informed and disciplined mind. It is the coalescence of these two factors that has made Germany great; it is the combination of these elements which must prevent England from becoming small. We bless God for our able journalists, our orderly Parliament, and our free press; but we bless him still more for "the hardy English root" from which these good things have sprung. We need muscle as well as brains—character and resolution as well as expertness of intellect. Lacking the former, though possessing the latter, we have the bright foam of the wave without its rock-shaking momentum. Our place of study was the town of Marburg, in Hesse-Cassel, and a very picturesque town Marburg is. It clambers pleasantly up the hill-sides, and falls as pleasantly toward the Lahn. On a May day, when the orchards are in blossom, and the chestnuts clothed with their heavy foliage, Marburg is truly lovely. My study was warmed by a large stove. At first I missed the gleam and sparkle from flame and ember, but I soon became accustomed to the obscure heat. At six in the morning a small milch-brod and a cup of tea were brought to me. The dinner-hour was one, and for the first year or so I dined at an hotel. In those days living was cheap in Marburg. Dinner consisted of several courses, roast and boiled, and finished up with sweets and dessert. The cost was a pound a month, or about eightpence per dinner. I usually limited myself to one course, using even that in moderation, being already convinced that eating too much was quite as sinful, and almost as ruinous, as drinking too much. By attending to such things I was able to work without weariness for sixteen hours a day. My going to Germany had been opposed by some of my friends as Quixotic, and my life there might, perhaps, be not unfairly thus described. I did not work for money; I was not even spurred by "the last infirmity of noble minds." I had been reading Fichte, and Emerson, and Carlyle, and had been infected by the spirit of these great men. Let no one persuade you that they were not great men. The Alpha and Omega of their teaching was loyalty to duty. Higher knowledge and greater strength were within reach of the man who unflinchingly enacted his best insight. It was a noble doctrine, though it might sometimes have inspired exhausting disciplines and unrealizable hopes. At all events, it held me to my work, and, in the long cold mornings of the German winter, defended by a Schlafrock lined with catskin, I usually felt a freshness and strength—a joy in mere living and working, derived from perfect

health—which was something different from the malady of self-righteousness. I concentrated my chief attention upon mathematics, physics, and chemistry. To the illustrious chemist Bunsen I am specially indebted. He was a man of fine presence, tall, handsome, courteous, and without a trace of affectation or pedantry. He merged himself in his subject; his exposition was lucid, and his language pure; he spoke with the clear Hanoverian accent which is so pleasant to English ears. He was every inch a gentleman. After some experience of my own, I still look back on Bunsen as the nearest approach to my ideal of a university teacher. Professor Stegmann gave me the subject of my dissertation when I took my degree. Its title in English was, "On a Screw Surface with Inclined Generatrix, and on the Conditions of Equilibrium on such Surfaces." I resolved that if I could not, without the slightest aid, accomplish the work from beginning to end, it should not be accomplished at all. Wandering among the pine-woods, and pondering the subject, I became more and more master of it; and when my dissertation was handed in to the Philosophical Faculty it did not contain a thought that was not my own. Continuing to work strenuously but happily till the autumn of 1850, I then came to England. But I soon returned to Germany. To those Marburg days I look back with warm affection, both in regard to nature and to man. To Berlin I went in the beginning of 1851. Magnus, Dove, Mitscherlich, Heinrich and Gustav Rose, Ehrenberg, Riess, Du Bois-Reymond, and Clausius were the scientific stars of the university at that time. From all these eminent men I received every mark of kindness, and formed with some of them enduring friendships. Helmholtz was at this time in Königsberg. He had written his renowned essay on the "Conservation of Energy." In his own house I had the honor of an interview with Humboldt. He rallied me on having contracted the habit of smoking in Germany, his knowledge on this head being derived from my little paper on a water-jet, where the noise produced by the rupture of a film between the wet lips of a smoker is referred to. He gave me various messages to Faraday, declaring his belief that he (Faraday) had referred the annual and diurnal variation of the declination of the magnetic needle to their true cause—the variation of the magnetic condition of the oxygen of the atmosphere. I was interested to learn from Humboldt himself that, though so large a portion of his life had been spent in France, he never published a French essay without having it first revised by a Frenchman. In those days I not unfrequently found it necessary to subject myself to a process which I called depolarization. My brain, intent on its subjects, used to acquire a set, resembling the rigid polarity of a steel magnet. It lost the pliancy needful for free conversation, and to recover this I used to walk occasionally to Charlottenburg or elsewhere. From my experiences at that time I derived the notion that hard thinking and fleet talking do not run together.

Far from seeing in this address a display of egotism, you will, I believe, accept it as a fragment of the life of a brother who has felt the scars of the battle in which many of you are now engaged. Duty has been mentioned as my motive force. In Germany one heard this word much more frequently than the word glory. The philosophers of Germany were men of the loftiest moral tone. In fact, they were preachers of religion as much as expounders of philosophy. It would to a certain extent be true to say that from them the land takes its moral color; but it should be added that the German philosophers were themselves products of the German soil, probably deriving the basis of their moral qualities from a period anterior to their philosophy. I asked two Prussian officers whom I met in the summer of 1871, at Pontresina, how the German troops behaved when going into battle—did they cheer and encourage each other? The reply I received was: "Never in our experience has the cry, 'Wir müssen siegen'—we must conquer—been heard from German soldiers; but in a hundred instances we have heard them resolutely exclaim, 'Wir müssen unser Pflicht thun'—we must do our duty." It was a sense of duty rather than love of glory that strengthened those men and filled them with an invincible heroism. We in England have always liked the iron ring of the word "duty." It was Nelson's talisman at Trafalgar. It was the guiding star of Wellington. When in his days of freshness and of freedom our laureate wrote his immortal ode on the death of the Duke of Wellington, portions of which both he and others might well take to heart at the present moment, he poured into the praise of duty the full strength of his English brain:

"Not once or twice in our rough island story
The path of duty was the way to glory:
He that walks it, only thirsting
For the right, and learns to deaden
Love of self, before his journey closes
He shall find the stubborn thistle bursting
Into glossy purples which outredden
All voluptuous garden roses."

—*Pall Mall Budget.*

GLADIATORS OF THE SEA.*

By FREDERIK A. FERNALD.

IN the ancient city of Siena, secluded among the hills of Northern Italy, Christopher Columbus received his education, and there, over the portal of the old collegiate church, hangs a memento of his

* This article is largely made up from "Materials for a History of the Sword-fishes," by G. Brown Goode, in the "United States Fish Commission Report for 1880," from which the cuts have also been obtained.

earliest voyage across the Atlantic. It consists of the arms and armor worn by the discoverer when he first set foot upon land in the New World, and the weapon of a native killed by his men before they reached the shore—the sword of a sword-fish. The names of this fish in he principal languages of Europe are simply variations of the *Gladius* of ancient Italy, and *Xiphias*, the name by which Aristotle, the father of zoology, called the same fish twenty-three hundred years ago. At the very inception of binomial nomenclature Linnæus called it *Xiphias gladius*, by which name it has been known to science ever since. The form of the sword-fish may be seen in Fig. 1. It is without scales. Its color is a rich purplish blue above, shading into silvery white beneath; the lower side of the beak is brownish purple. A sword-fish which does not exceed the average weight of a man is a small fish; the average weight is about three hundred and fifty pounds, and doubtless many attain the weight of five hundred pounds, but fish weighing above six hundred are exceptional. Newspapers are fond of recording the occurrence of giant fish, weighing fifteen hundred pounds and upward,

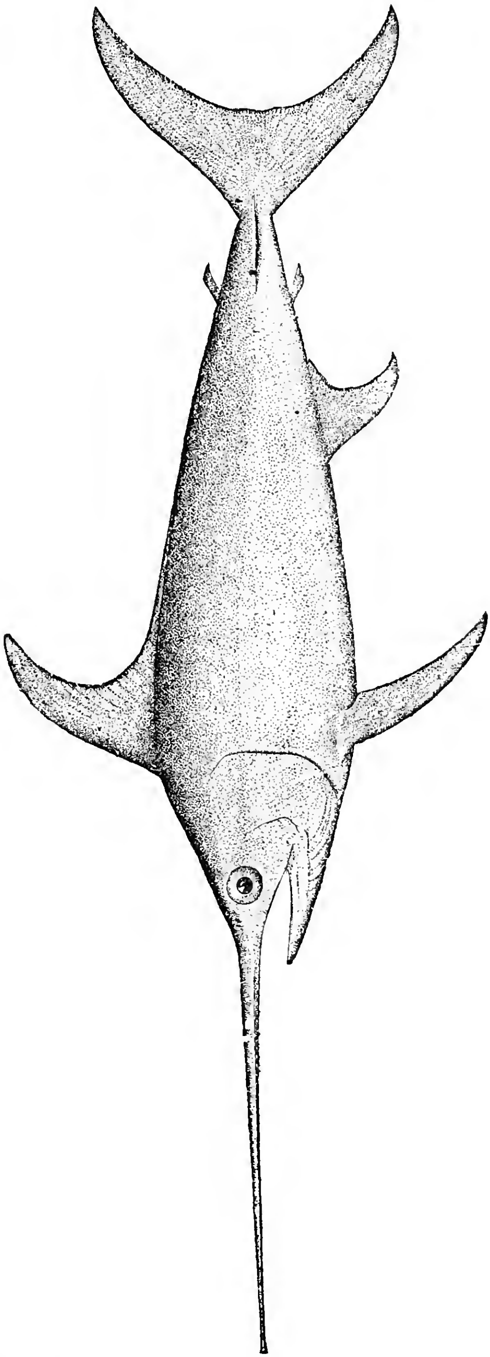

Fig. 1.—The Sword-Fish (*Xiphias gladius*).

and old sailors will in good faith describe the enormous fish which they saw at sea but could not capture; one well-authenticated instance of accurate weighing, however, is much more valuable. The average extreme length seems to be eleven feet, of which the sword is nearly four feet. A fish has been taken by Captain Benjamin Ashby, a New England sword-fisherman, whose sword measured almost six feet. The fish when salted weighed six hundred and thirty-nine pounds, so that its live weight must have been as much as seven hundred and fifty pounds.

The sword-fish ranges along the Atlantic coast of America from Jamaica to Nova Scotia; it is abundant on the shores of Western Europe, entering the Baltic and Mediterranean Seas, and is found also on the west coast of Africa, about New Zealand, and along the Pacific coast of America from Peru to California. On the coasts of Maine, Massachusetts, and Rhode Island they abound in the summer months; their occurrence off New York is not unusual, but in our Southern waters they do not appear to remain.

A sword-fish when swimming near the surface usually allows its dorsal fin and the upper lobe of its caudal fin to stand out of the water several inches. It is this habit which enables the fisherman to detect the presence of the fish. It commonly swims so slowly that a fishing-smack with a light breeze has no difficulty in overtaking it, but when excited its motions are very rapid and violent. Many curious instances are on record of attacks by this fish upon ships. Ælian, who wrote a little later than 200 A. D., says that the sword-fish has a sharp-pointed snout with which it is able to pierce the sides of a ship and send it to the bottom. He describes the sword as like the beak of the ship known as the trireme, which was rowed with three banks of oars. In 1871 the little yacht Redhot, of New Bedford, was out sword-fishing, and a sword-fish had been hauled in to be lanced, when it attacked the vessel and pierced her side so as to sink her. The London "Daily News" of December 11, 1868, contained the following paragraph, probably from the pen of Professor R. A. Proctor: "Last Wednesday the Court of Common Pleas—rather a strange place, by-the-by, for inquiring into the natural history of fishes—was engaged for several hours in trying to determine under what circumstances a sword-fish might be able to escape scot-free after thrusting his snout into the side of a ship. The gallant ship Dreadnaught, thoroughly repaired and classed A 1 at Lloyd's, had been insured for three thousand pounds against all the risks of the seas. She sailed March 10, 1864, from Colombo for London. Three days later the crew while fishing hooked a sword-fish. Xiphias, however, broke the line, and a few moments after leaped half out of the water, with the object, it should seem, of taking a look at his persecutor, the Dreadnaught. Probably he satisfied himself that the enemy was some abnormally large cetacean, which it was his natural duty to attack forth-

with. Be this as it may, the attack was made, and at four o'clock the next morning the captain was awakened with the unwelcome intelligence that the ship had sprung a leak. She was taken back to Colombo, and thence to Cochin, where she was hove down. Near the keel was found a round hole, an inch in diameter, running completely through the copper sheathing and planking. As attacks by sword-fish are included among sea-risks, the insurance company was willing to pay the damages claimed by the owners of the ship if only it could be proved that the hole had really been made by a sword-fish. No instance had ever been recorded in which a sword-fish had been able to withdraw his sword after attacking a ship. A defense was founded on the possibility that the hole had been made in some other way. Professor Owen and Mr. Frank Buckland gave their evidence, but neither of them could state quite positively whether a sword-fish which had passed its beak through three inches of stout planking could withdraw without the loss of its sword. Mr. Buckland said that fish have no power of backing, and expressed his belief that he could hold a sword-fish by the beak; but then he admitted that the fish had considerable lateral power, and might so 'wriggle its sword out of a hole.' And so the insurance company will have to pay nearly six hundred pounds because an ill-tempered fish objected to be hooked, and took its revenge by running full tilt against copper sheathing and oak planking."

The instrument with which such damage is done is a flat, bony prolongation of the upper jaw, which tapers slightly to a nearly square end. Fig. 2, although representing the weapon of a very young fish, will serve to show the appearance of the upper and under sides of the sword. Its material is not very hard, and it would fail to pierce a ship's timbers but for the enormous swiftness with which it is driven by the charging fish.

An unsigned article in "Harper's Weekly" for October 25, 1879, contains a mention of a sword being found, in 1725, imbedded as deeply in the side of the British ship Leopard as an iron bolt of the same size could be driven by nine strokes of a twenty-five-pound hammer. Yet the fish drove it in at a single thrust. The same writer tells the following still more remarkable story: "On the return of the whale-ship Fortune to Plymouth, Massachusetts, in 1827, the stump of a sword-blade of this fish was noticed projecting like a cog outside, which, on being traced, had been driven through the copper sheathing, an inch board under-sheathing, a three-inch plank of hard wood, the solid white-oak timber twelve inches thick, then through another two-and-a-half-inch hard oak ceiling, and lastly penetrated the head of an oil-cask, where it stuck, not a drop of the oil having escaped."

One of the traditions of the sea, time-honored, believed by all mariners, handed down in varied phases in a hundred books of ocean-travel, relates to the terrific combats between the whale and the sword-

fish aided by the thresher-shark. The fierce gladiator was said to attack from below, goading his mighty adversary to the surface with his terrible weapon, while the thresher, at the top of the water, belabored him with his long, lithe tail. Skeptical modern science is not satisfied with this interpretation of any combat at sea seen at a distance. It recognizes the improbability of aggressive partnership between two creatures so different as the sword-fish and a shark, and explains the turbulent encounters occasionally seen at sea by ascribing them to the attacks of the killer-whale upon larger species of the same order.

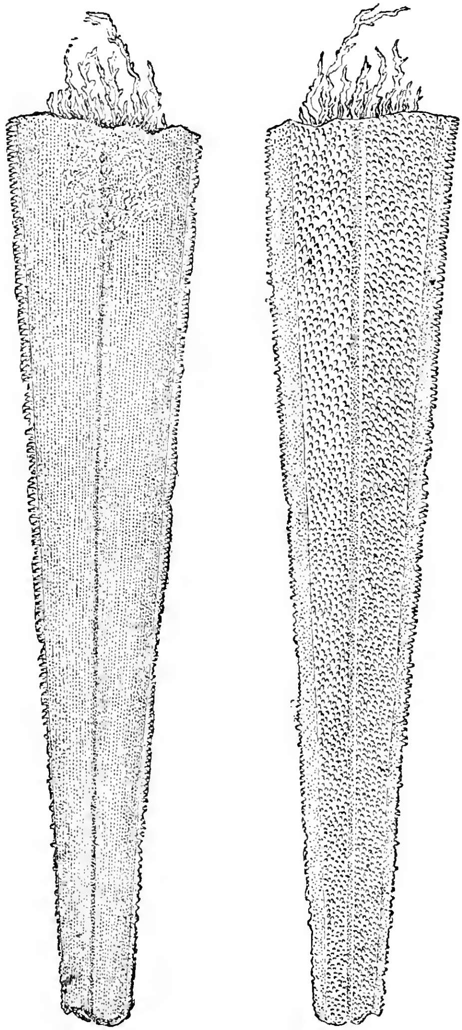

Fig. 2.—Sword of Young Sword-Fish.

Such a large animal as the sword-fish can have but few formidable antagonists. The tunny, or horse-mackerel, other sword-fishes, and sharks, are its only peers in size, and of these the sharks are probably its worst foes. Mr. John A. Thomson, of New Bedford, states that the bill-fish is an inveterate enemy. Bill-fish appear about the last of the season, and the sword-fish are sure to leave soon after. Many species of parasites are found upon the sword-fish; some hang on the gills, others fasten themselves to different parts of the alimentary canal, and others still bore into the flesh. They may be divided into two groups, worm-like parasites and crustacean parasites, the latter resembling small crabs and lobsters. Several species, as might be expected from the size of the fish, are among the giants of their races. There is also a species of remora or sucker which is often found attached to the gill-cover of the sword-fish, and to no other fish. It is, however, to be regarded as a messmate rather than as a true parasite.

Although sword-fish are so plentiful in American waters, they are never seen of less than three feet in extreme length. Old fishermen who have taken and dressed them by the hundreds state that they have never found any traces of spawn in them. The absence of young fish and spawning females would indicate that they do not breed on our coast. In the Mediterranean the young are so plentiful as to be a common article of food. The appearance of the young fish when about an inch and a half long is shown in Fig. 3.

Menhaden, mackerel, bonitoes, blue-fish, and other species which swim in close schools, are the usual food of the sword-fish. A school of small fish has been seen crowded together near the surface, when their enemy appeared rising through the dense mass, and half out of water, and literally fell upon them with the sword and slew them in large numbers. Menhaden have been found floating which have been cut nearly in two by a blow of the sword. It is in pursuit of these fish that the sword-fish come to our Northern Atlantic shores in the summer months. The sword-fishery season opens in the neighborhood of Sandy Hook about the first of June; the fish are very abundant about Block Island and Nantucket in July and August, disappearing with the first cold weather in October. They are, like mackerel, at first very poor and lean, but as the season advances they grow fatter. For many years from three to six thousand have been taken annually on the New England coast, and there are no signs of any decrease or increase in their numbers. It is not unusual for twenty-five or more to be seen in the course of a single day's cruising, and sometimes as many as this are in sight from the mast-head at one time. One Gloucester schooner, the Midnight, Captain Alfred Wixon, took fourteen in one day, in 1877, on George's Banks.

The apparatus ordinarily employed for the capture of the sword-fish is a harpoon with a detachable head. The pole is of hard wood, fifteen or sixteen feet in length, and from an inch and a half to two inches in diameter. To this is fastened an iron rod or shank, about two feet long and five eighths of an inch in diameter, and having a deep socket into which the pole sets. Upon the end of the shank fits somewhat securely the head of the harpoon, known to the fishermen by the names "sword-fish iron," "lily-iron," and "Indian dart." The lily-iron consists of a two-pointed piece of metal, having a socket running lengthwise on one side at the middle. In this is inserted the end of the harpoon-shank, and to it or near it is attached also the harpoon-line. When the iron has been plunged point first into the body of the fish, it is released by the withdrawal of the pole from the socket, and, by the pull of the line attached at its middle, is at once turned crosswise to the opening through which it entered, and is thus prevented from withdrawal.

The fish are always harpooned from the end of the bowsprit of a sailing-vessel. All vessels regularly engaged in this fishery are sup-

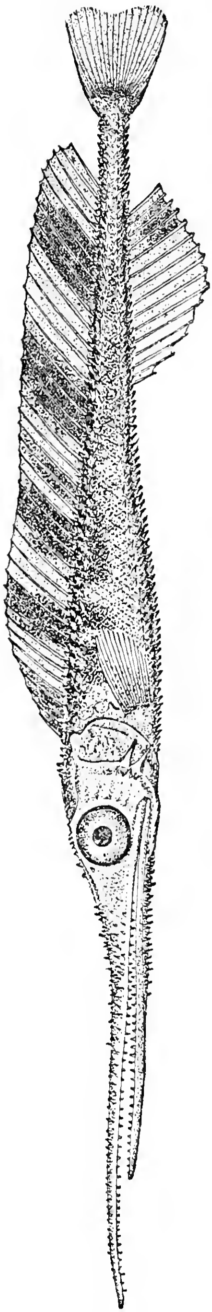

Fig. 3.—Young of Sword-Fish.

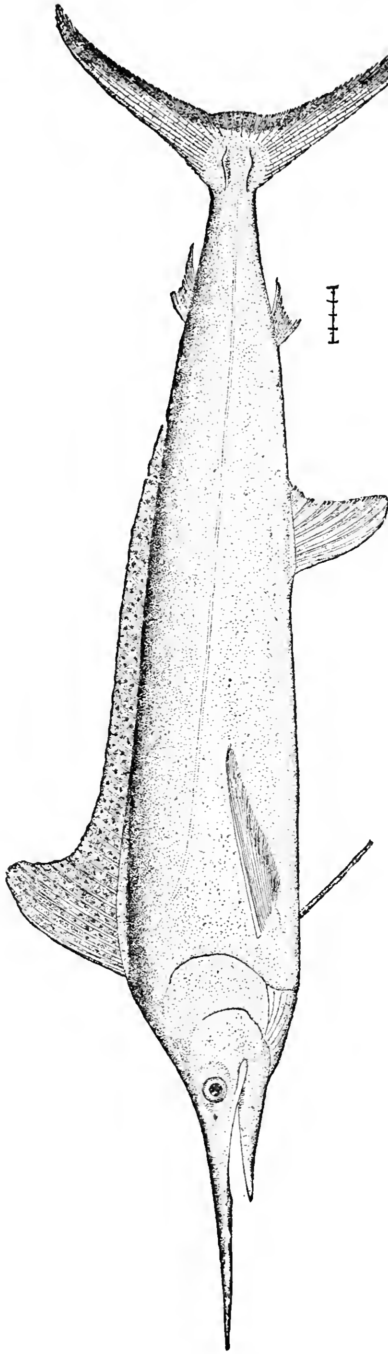

Fig. 4.—The Western Atlantic Spear-Fish (*Tetrapturus albidus*). Poey.

plied with an apparatus for the support of the harpooner, which consists of a wooden platform about two feet square, upon which the

harpooner stands, and an upright bar of iron three feet high, rising from the tip of the bowsprit just in front of this platform. At the top of this bar is a bow of iron in a nearly circular form, to surround the waist of the harpooner. This structure is called the "rest" or the "pulpit." A man is always stationed at the mast-head, whence, with the keen eye which practice has given him, he can easily descry the tell-tale dorsal fins at a distance of two or three miles. When a fish has been sighted, the watch "sings out," and the vessel is steered directly toward it. The skipper takes his place in the pulpit, holding the harpoon with both hands by the upper end, and directing the man at the wheel by voice and gesture how to steer. When the fish is from six to ten feet in front of the vessel, it is struck. The harpoon is not thrown; the strong arm of the harpooner punches the dart into the back of the fish beside the dorsal fin, and the pole is withdrawn. The line is from fifty to one hundred and fifty fathoms long, and the end is either made fast on board the smack, or attached to a keg or some other form of buoy and thrown overboard. After the fish has exhausted himself by dragging the buoy through the water, it is picked up, the fish is hauled alongside, and killed with a lance. In the mean time, several other fish may have been struck and left to tire themselves out in the same way. The following interesting account of the taking of a sword-fish is from an article by Mr. C. F. Holder, published several years ago in "Forest and Stream": "The man waited until we were almost upon them, and as one of them turned, as if in idle curiosity, to see what the great shadow meant, he hurled a spear, and the next moment the huge fish sprang from the water and, with a furious twist, tried to shake out the iron. So great was the effort that it fell on its side with a crash, and for a moment was still, but it was only for a second. The line jumped into activity, and rushed out so you could not follow it, now swaying to and fro and making the water fly like rain. About fifty feet of line had gone out, when six of us managed to get a fair hold on the line, and attempted to try our strength. If six individuals were ever jerked around in a more vivacious manner, they have my utmost sympathies. Now the swordfish would land us all together in a heap, then slacken up, and take us unawares, throwing us to the deck with a force that fully came up to my preconceived ideas of the sport. He would undoubtedly have dragged us all overboard if the rope had not been sure and fast. This sort of fun was kept up for about fifteen minutes, when the fish perceptibly weakened, and the long rushes to the right and left grew feebler and feebler, until we ventured to haul in. At last we had the brute alongside. A rope was rigged from the peak and fastened around the long sword, and the monster was rolled on board the sloop. We measured our game, which was nine feet six inches long. Though I have frequently caught sharks which measured thirteen feet, I never saw any that showed near the strength of this peculiar

creature." This marine gladiator is not always content to seek only to escape. He knows the capabilities of the weapon which he wields, and sometimes proves a powerful antagonist, sending his pursuers' vessel into harbor almost sinking from injuries which he has inflicted. The fishermen, too, occasionally receive injuries from his sword. One of Captain Ashby's crew was severely wounded by a sword-fish which thrust its beak through the bottom of a boat in which the man was standing, and penetrated two inches into his naked heel. One or two instances are on record of the capture of sword-fish upon an ordinary hand-line, and it is probable that this is much more common than has been usually supposed. Within the past few years it has not been unusual for sword-fish to become entangled in the long lines of halibut-fishermen on the northern banks. This manner of taking them is, of course, purely accidental, and is rather vexatious than otherwise to the fishermen.

The bulk of the yearly catch is sold fresh. Most of the fish are taken into New Bedford, and some are carried to New London. Until quite recently nearly all were disposed of in that vicinity. About 1864 a few were sent to Boston as an experiment, and the demand for sword-fish in that market has since rapidly increased. It is not well known in New York. When the first fish reaches New Bedford, it is eagerly sought at twenty cents a pound retail. In 1873 within forty-eight hours after the arrival of the first one, fifty-two were brought in, bringing the retail price down to eight and ten cents, for which the fish clear of bone is usually retailed throughout the season. The wholesale price for "clean fish" is about twelve cents for the first catch, falling rapidly to two or three cents. The fish is of a gray color, its texture is coarse, somewhat resembling halibut, and though a trifle oily is a very acceptable article of food. Its flavor is by many considered fine, and is not unlike that of the blue-fish. Sword-fish are usually cut up into steaks, thick slices across the body, which may be broiled or boiled.

In Fig. 4 is shown another member of the sword-fish family, the bill-fish or spear-fish. It occurs on our Atlantic coast from the West Indies to Southern New England, and in nearly the same foreign waters in which its more celebrated relative is found. It resembles the sword-fish in movements and manner of feeding. About Mauritius they are taken in deep water with hook and line, or speared when near the surface. When hooked or speared they are said to make for the boats, taking tremendous leaps in the air, and if care is not taken they will jump into the boats, or pierce them with their bills, to the great consternation of the fishermen. The species attains a large size, one having been seen measuring twenty-six feet. The fish is highly esteemed in the Mauritius. Near the backbone it is of a salmon-color; lower down it is red and like coarse beef.

The sail-fish is a member of this family, and is especially notable

for its enormous dorsal fin. Its range may be said to be from 30° south to 40° north latitude. No observations have been made upon the sail-fish in this country. In the life of Sir Stamford Raffles there is the following account from Singapore, under date of November 30, 1822: "The only amusing discovery we have recently made is that of a sailing-fish, called by the natives *Ikan layer*, of about ten or twelve feet long, which hoists a mainsail, and often sails in the manner of a native boat, and with considerable swiftness. I have sent a set of the sails home, as they are beautifully cut, and form a model for a fast sailing-boat. When a school of these are under sail together they are frequently mistaken for a fleet of native boats." The appearance of this fish is shown in Fig. 5.

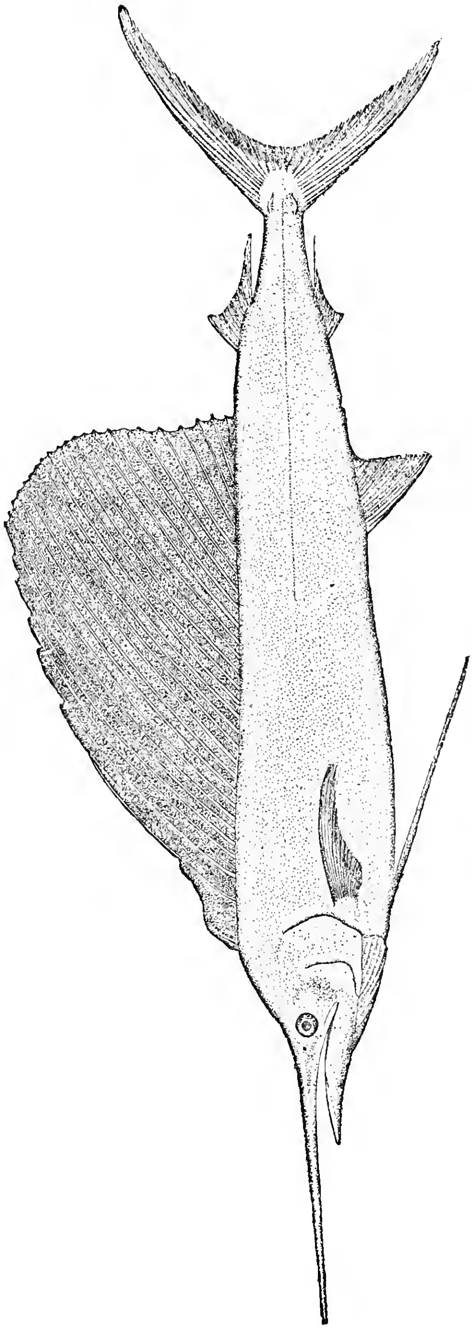

FIG. 5.—THE AMERICAN SAIL-FISH (*Histiophorus Americanus*).

A sketch of the gladiators of the sea would not be complete without some mention of the saw-fish and the narwhal. The saw-fish family is allied to the sharks, having a similar elongated and rounded body, and unequal tail-lobes. They are found in most warm seas and even near the poles; one species is met with all along the Atlantic coast of the United States. They are rapid swimmers. The mouth is

on the under side of the head, and is furnished with teeth which are adapted to crushing crustaceans and similar creatures upon which they feed, and not for tearing flesh. Behind the eyes they have two large blow-holes.

The common saw-fish reaches a length of twelve to fifteen feet, of which the saw is about one third. It carries a much uglier weapon than the sword-fish, for along the edges of its beak are set pointed conical teeth, two or three inches apart. The number of teeth on each side varies from twenty to thirty. The "saw" is not used by being drawn backward and forward: in killing small fishes for food, the saw-fish charges among them, striking to the right and left with the serrated edges of its beak, and generally succeeds in disabling a considerable number. When a whale is the creature attacked, this terrible weapon is plunged into the soft, blubber-covered body of the cetacean, the saw-fish avoiding by superior agility the strokes of the tortured animal's tail, any one of which would end the career of the daring gladiator. His weapon is often found deeply imbedded in the side of a ship, and even after the death of its original owner the beak may still inflict grievous wounds, for the Polynesians are fond of using it as a sword.

The narwhal belongs to the order of whales, and hence is not a fish. When full grown it reaches a length of about sixteen feet; it has the rounded body and horizontally flattened tail of the whales, but its head is small and rounded more like that of the seal. It inhabits the Arctic seas, and is a valuable game for the Greenlanders, as its flesh is much prized by them, and it yields a moderate quantity of very delicate oil. The color of its skin is gray, varied by darker streaks and patches, and shading from almost black above to white underneath. The curious horn to which the narwhal owes its fame is not a prolongation of the jaw as in the case of the fishes just described, but is a long tooth, like the tusks of the elephant or the boar. In the upper jaw of the young narwhal are found two small tusks, which in the female regularly remain undeveloped throughout her life. In the male the left tusk grows into a spirally grooved rod, sometimes attaining the length of ten feet. A large narwhal's tusk has no small commercial value, for the ivory is very hard and solid, will take a high polish, and keeps its beautiful whiteness a long time. Several ingenious speculations have been made in regard to the use of this remarkable growth; killing fish for food and breaking breathing-holes through the ice are two uses suggested which fail to account for the long tusk being confined to the males. The females certainly can not live on air alone, nor without air, and they can not count on always having a male near to wait upon them. It is more probably to be accounted for by the same reasons which explain the possession of horns, tusks, or mane by the males only of some land mammals. Rarely the right tusk is developed instead of the left, and sometimes the female has a weapon

like that of her mate. One female has been taken with both tusks developed, one being seven feet in length, the other five inches longer. Like his fellow-gladiators of the sea, the narwhal will occasionally thrust his gigantic foil into the side of a ship, where it usually breaks off, and, fitting the hole like a plug, seldom causes a leak. Narwhals are generally seen in herds of fifteen or twenty; they will come close about a ship, apparently from curiosity, and it is one of the most entertaining sights of the northern seas to watch them plunging about, spouting spray from their blow-holes, and clashing their long weapons together as if fencing.

STUDYING IN GERMANY.

By HORACE M. KENNEDY.

THE tangible influence of Continental Europe, and especially of Germany, upon our thought and life, our education, habits, and morals, is perhaps greater than we are wont to grant or appreciate. This is in part due to the annual transfer of large sections of the German population to our shores and their absorption into our social system; but it is owing still more to the migration of Americans to Germany, where they come in contact with institutions that seem usually to impress them favorably. We often find ourselves speaking, with some chagrin at our own achievement, of German schools, of German purity in municipal government, of German stability and efficiency in the civil service, and of the self-respecting modesty of German boys and girls. Besides the hosts of tourists who jostle each other on the beaten courses of travel between the Rhine and Vienna, there is a steadily growing class of Americans who visit Germany to spend from one to five years in study. The American students at the great German universities now outnumber those from any non-German nation of Europe; and their number is greater than that of all other non-Continental states together. We may divide the American students in Germany into two classes: 1. Boys and girls sent or accompanied thither to get their preliminary education, and ranging in age from twelve to twenty years. These should be subdivided into—first, special students of music; and, second, students of such branches as are taught in our high-schools. 2. Young men, usually graduates of college, who wish to push their studies in special departments. Among the latter are often men who have already practiced their professions. The second class chiefly contains students of philology, medicine, and physics or chemistry. In any case this residence of several years in a foreign country acts profoundly upon the character of the student, and in ways quite outside of his book-knowledge.

First, let us consider those who go to prepare for college, or for a pro-

fession, or it may be, in the technical language of society, to "finish"; to study with private tutors, or in the gymnasium, or the *Realschule* (real-school). Though many of these students are girls, and many of the objections given also hold good in their case, we shall confine ourselves to boys. Of course, no careful parent would permit his daughter to reside in a foreign country, save under judicious chaperonage; no young girl should be personally subjected to the trials of making her own way among the officials and the managers of *pensions* in a German city. Some parents place their sons in Leipsic or Berlin, because they have observed that it is the thing to do; others, because they honestly think their children will profit by it—that is, more than they would at school, during the same time, at home. The fame of German schools and teachers may justify the latter view. In scope, purpose, and magnanimity, no schools surpass the German gymnasia and real-schools; and if we take the system throughout the nation and set it beside our school system as a whole, as applied in town and country and in various States, it is far superior, in all that education means, to it and to any other existing system. But, after a residence of over two years in German cities, and after some study of their secondary schools, I am convinced that our best high-schools and academies, public and private, are equal to the best German schools. The question, however, whether a boy at a German school would be better taught in his languages and mathematics, his sciences and his history, is not here pertinent. Grant for the moment that he is better taught; is he, by his German training, better fitted as a man to meet the questions of American life, and to succeed in his calling in America? At the age when his mind is most plastic, when those impressions are received that are to abide by him longest, he is transplanted to a society whose salient features are in reality startlingly unlike those amid which he is to make his way in life. I shall not attempt to decide whether these traits and ideas are preferable to our own; it is enough that they are different. Certain it is, for instance, that a boy in Germany is made unpractical; and that is a fatal quality in an American boy. He is filled with a love of research for its own sake, not for the sake of its bearing upon direct practical results. I should say that this is the chief quality which the boy is sure to get, and which will, in varying degrees, unfit him for the demands of his later work in any calling at home. He will be made impractical and speculative. The Germans are discoverers and recorders of facts, but they are poor at applying them. The boy also loses his sense of the value of time. Where all men, business and professional, move slowly, where it is the rule for the merchant, or the editor, to spend two hours at midday at his dinner and coffee, where "soon" means half a day, and "at once" an hour, the native boy does not suffer if he grows up in an atmosphere of deliberation. But this will not do in Broadway. Again, German boys are overworked. The American boy's school-life is easy com-

pared with the steady drill of the gymnasium and real-school, and he must compete with students who not only seem proof against poor ventilation and poor food, but are used to hard labor and short vacations, and he must do it in a foreign tongue. All gymnasium students must do work during the short summer vacation, requiring not less than one hour, and not more than two hours, daily. The course of the gymnasium lasts nine years. During the first seven years, there are ten hours per week of recitation in Latin, and, throughout the last seven years, six hours per week of Greek. The number of hours of recitation per week can not exceed thirty-two, and it can not be less than twenty-seven. There are no Saturday holidays, so that the time spent in recitation at school averages five hours a day. The law permits but ten weeks of vacation in the year: four weeks beginning on the third Saturday in July, two weeks at Christmas, two at Easter, one at Whitsuntide, and one at the end of the summer semester. The morning session begins at eight o'clock, and lasts until twelve, when there is a recess of one hour. Lessons are then continued until six o'clock. This is the plan every day, save Saturday and Wednesday, when the afternoon session is omitted. Compared with the work of an American high-school, this is stupendous, and it must tend to endanger the health of any pupil.

A symptom of overwork among German boys is short-sightedness and other diseases of the eye; this is so general that most travelers note it as a national characteristic. Not only do the majority of men who have studied wear glasses, but it is safe to say that a third of the school-boys wear them. This is said to be due to the intricacies of the German type; but poor ventilation, close application, and bad lighting can not fail also to weaken the eyes, and the American boy escapes none of the primitiveness of German home and school life.

Another loss which our typical boy suffers is in his Americanism. I am not fully prepared to say that in many respects this loss is not a gain, if you consider the boy as a sort of ideal abstraction; but, as regards his patriotism, his working power as a force in the community where he is to live, and his success in life, it is an actual loss. Imperceptibly he comes to regard the peasant, the servant, the hand-worker, as an inferior being. The sight of women helping dogs draw carts, or sawing wood in the streets, soon fails to shock him. In the larger sense he ceases to be a democrat; the grown man resists the forces which inevitably stamp the school-boy. And in the narrower sense, touching manners, personal habits, and speech, the boy is more markedly affected, and in ways which at home may lay him open to the charge of snobbery or pedantry. Although the rules of the gymnasium forbid beer-drinking and smoking, and teachers are responsible for the observance of these rules, the very atmosphere of a German town is so redolent of beer and smoke that the boy acquires a laxness regarding these habits which makes him out of place, and puts him at

a disadvantage, in a country where public opinion calls drinking a vice and where total abstinence is possible. He learns to shrug his shoulders in order to express the slightest doubt or innuendo, and he may easily learn to eat with his knife and make a noise at his soup. He will get methods of thought and points of view in themselves lofty, catholic, and public-spirited, which will, nevertheless, in his own country, as things are, retard rather than advance his career. The relations of school-boys, and even of men, with each other are so different from the intercourse of American students, that a boy may forget how to live comfortably with his fellows on his return. Again, a boy, well brought up and conscientious, when placed with liberal allowances of money in a German city, far from the restraints of home and associates, may get into ways that are unmistakably vicious and immoral. This is a danger that many parents discern when it is too late. The young man's position is perilous, especially when he is merely in the hands of private tutors, and lives in a *pension* or an hotel. I have myself known several boys who in two or three years in Leipsic and Berlin went from bad to worse—boys who at home in school or college would never have lost their footing. In German cities there is also a certain all-pervading tone of cynicism as regards religion, taken in the stricter sense. It is not fashionable, as with us, for the more intellectual people to go to church. Prussia is a Protestant nation ; even Bismarck may be "evangelical" when occasion requires, and churches and preachers are not lacking. But the people whom the school-boy meets are usually agnostics or liberals—those who admire Luther as a man detest the raving atheism of the social-democrats, and are quite respectable. These are influences which few parents wish their boys to meet before they are matured.

Now, what is gained to offset these drawbacks and dangers? We will assume that the pupil could attend a good school at home, and that the expenditure of foreign travel and tuition would support him at such a school : the only real gain is a knowledge of German. He will certainly learn German. But on this point bears one fact which few appreciate. In his residence of from one to five years in Germany, speaking, reading, and writing little but German, the boy suffers a great loss in his English. This is the period when at home he is enriching his vocabulary and forming his style by English composition and the reading of English books. I would not undervalue the power one wields who has at command a great modern language, especially a language like the German, whose intrinsic beauty and force, and the wealth of whose literature, may go far to form the culture of any man. But, in making up a balance for the boy whose parents wish to have him trained abroad, this sacrifice of the mother-tongue must not be ignored.

These are some of the conditions suggested by the first class of students abroad. What is to be said as regards university students,

who are usually adults and specialists? In their case most of the foregoing objections do not hold; in fact, the situation is nearly reversed. We have no institutions which are the original fountains of scholarship, as are the German universities. The character, language, habits, of the men who study in them are in a measure formed. From observation I should say that the average age of Americans studying at the German universities is twenty-five. A graduate of one of our colleges or leading academies is ready to get and appreciate the best that the universities offer, as well as to observe and weigh the political and social elements in which he moves. His vacation travel is itself a delight and an education. The benefits of such study to men are so well understood that to point them out more in detail would be needless. But practical information as to the conditions of study, as to courses and degrees, is so vague, and in newspapers and magazines often so erroneous, that some facts may be given here. The graduate of any American college may matriculate, in full standing, at a German university on the presentation of his diploma and a passport. These take the place of the certificate of maturity (*Maturitätszeugniss*) from the gymnasium or real-school, which the German candidate must submit. Men who have no college diploma may attend lectures and have access to all privileges, but they may not become candidates for a degree. There is an impression that American students must encounter special difficulties in seeking a degree, and that few succeed in gaining it. This is an error. Many students do not *choose* to take the required subsidiary studies, lying perhaps outside of their special field, and hence do not try to get the degree. But it is a fact that fewer difficulties beset the American in this quest than the German himself. The university is the regular and essential avenue to the professions and many civil careers, and competition is very keen. But the faculties well know that the American does not seek promotion on German soil; they recognize the compliment of his long pilgrimage to their shrines, and they are willing to encourage him, avoiding the appearance of anything like a protective tariff. In the range of my acquaintance, as many as nine Americans have won the coveted title of Doctor of Philosophy, the degree now common to all departments; in some cases it has seemed that they met fewer difficulties than the German candidate, and in no case were the tests severer. The usual time necessary for this sort of graduation is six semesters, or three years. The student may spend each semester at a different university or all at the same one, if he chooses. And he may stand for a degree at any university he may select. The system is like that of a great society having many co-equal chapters. He must fix upon a special department of learning, and must follow two subordinate branches closely related to the main subject. During two or three years he "hears" lectures in the faculties dealing with his specialty. There are no examinations whatever before the final examination for the

degree, and no regular account is kept of attendance at lectures. He must give due notice of his intention to be a candidate, and must present a list of the lectures he has heard, the list certified by the signatures of the professors and of the quæstors; the latter officer vouches for the payment of all fees. But, most important of all, he must present a dissertation which shall be an original and thorough investigation in some portion, no matter how minute, of his general field of research. Though he is treated to a rigorous oral examination, this written work has the greater weight in forming the decision of the examiners.

But the degree is, after all, of little importance to the student; the question is, whether he would do well to study at the German university at all. In general, we may answer that the center of the world's scholarship is there, and, if a young man knows that he wants learning, there is the place to get it at its best. The allowances to be made for pedantry are not so grave as we are wont to imagine, and the fruits of ripe and patient investigation are offered, with a generous hand, in both lecture-room and pamphlet. There is, after all, no paradox in the conclusion that, while the boy may lose promptness, alertness, manners, fluency in English, and even health, the man gains, besides knowledge, incentives and standards that may make him a better citizen.

STATE USURPATION OF PARENTAL FUNCTIONS.

By Sir AUBERON HERBERT.

(*Letter to the London "Times."*)

SIR: Your reviewer, reviewing Mr. Spencer's valuable book of "Man *vs.* The State" with great sympathy and interest, seems to wonder why Mr. Spencer does not believe in and admire the Factory Acts. Surely to protect children against parents greedy of gain is and must be a right act seems to be his instinctive thought, as it is that of so many other persons.

Will you let me point out one reason why these acts were and always will be, till they are swept away, a very mischievous, though a well-meant, stupidity? They simply are one among the many other stupid attempts to make an official regulation take the place of the unselfish care of parents for their children. How absurd the whole thing seems as one looks quietly back on what took place! Before any acts were passed, parents were supposed—and probably with justice enough in many cases—to be overworking their children, selling their bone and muscle for the wages they received. The acts are passed, and then the air is filled with congratulations on the immense progress made. Moloch shall not be worshiped any more; the white slavery is over; neither the manufacturer nor the parent shall draw an unholy

profit from the very life of the children. How hollow and untrue the whole thing was! As if there would have been a single worshiper of Moloch, whether he was parent or manufacturer, the less on the morrow; as if, by the mere idle method of holding some meetings, getting some votes together, and passing an act of Parliament, one fiber in the nature of the Moloch-worshipers would have undergone change! I say deliberately the idle method, because here is the root of the whole matter. All these official reforms are essentially idle. Is the nation to be sober? Pass an act of Parliament out of hand, and shut up the public-houses. Is it to be provident? Pass an act of Parliament and compel men to make provision for themselves. Is it to be intelligent? Pass an act of Parliament and harry the homes till every child is at school. Is it to consist of unselfish and devoted parents? Pass a factory act, and tie the hands of the parent so that he can no longer sell his child's labor. Nothing is required of us but to hold some enthusiastic meetings, make some speeches, write some letters to the "Times," and scrape votes enough together, and then all these great things shall be done. Happy world! How easily it is to be cured of its faults! We may now sink back contentedly into our arm-chairs for the rest of our life, enjoy the testimonials we received in the moment of enthusiasm, admire the statues that were gratefully raised to us, and reperuse our own speeches, as there remains nothing else for us to do in presence of the regeneration in human nature that our last batch of regulations has effected. In view of this modern plan of growing good in ten minutes, we disquieted ourselves very uselessly in past days about the amount of original sin in human nature and the ills and infirmities to which human flesh was heir. What fools men are not to enjoy perfect health, when Holloway's pills, Clarke's blood-mixture, and Eno's fruit-salts are to be had for the ordering; and what fools they are not to become sober, provident, intelligent, and unselfish, when all that is wanted is only to pass two or three acts of Parliament to provide them with the qualities wanted!

The word idle seems to me to suit the case with great nicety. Taking care of the people by acts of Parliament seems to me very like the care of the mother for her child who rings the bell at the Foundling Institution, places her child on the door-step, and then contentedly goes on her own way. Let us suppose that she is doing the best for her child, still the trouble on her part is short and soon over. The long, slow years of anxiety and labor that fall to other mothers will not be for her.

It all ended for her, fortunate woman, when she rang the institution-bell. In the same way the political philanthropist has learned to lay his burden with but short delay on other shoulders than his own. The world's troubles are but an easy nut to crack according to his creed. A new law, a new office in some public department, a new batch of officials, will cure all human perversities from the parent that

does not send his child to school down to the abandoned city sinner who outrages Mr. Dowsett's feelings by playing cards in the railway-carriage. Why should we tread any longer that toilsome road by which men have sought to better themselves and each other? Why paint a picture by hand, when you can do it so well by a chromo-lithographic process? Why exert ourselves to enlist the active moral forces of society on our side; to work by sympathy, discussion, advice and teaching of every kind; by personal contact; by that wonderful force of example which makes every better kind of life a magnetic power among the lower kinds; by that softening of character and greater gentleness that diffuse themselves everywhere, as savagery of all kinds is just allowed to melt quietly away under the thousand influences of civilization; by raising and ennobling our own motives for helping each other, and, above all, by constant efforts to enlarge and increase our own powers of seeing truly, so that we may understand what are the causes of the evils we see round us, and what are the conditions under which they can be successfully attacked? All this is simply superfluous in presence of the modern omniscient and omnipotent act of Parliament. Think how much trouble, how many long years of slow conversion are saved by our present admirable process of compulsion. Charlemagne—not St. Paul or St. John—was the really enlightened Christian apostle. Be baptized, or ——, is the one argument specially fitted for the souls of men. But, however excellent these compulsions may be for the first ten minutes, still every ten minutes has its afterward; and let me now ask, what is the after-fruit borne by these compulsions? Let us take for granted that before the first factory acts were passed many children were overworked. There were two ways open for those to take who felt the wrong and wished to remedy it. There was the easy, rapid, and unfruitful parliamentary way; there was the way—slow, up-hill, but very rich in after-fruits—of appealing directly to the people to reform the thing for themselves. I know this last way would have been slow. I know that all those who wish to gather fruit before the tree is planted would have exclaimed, "And meanwhile the children are left to suffer." I know it would have required a personal devotion and belief in their work far greater than that which is necessary for conducting a parliamentary agitation, with its showy and rather sensational rewards; but I also know that in the end the parent would not simply be rendering mechanical obedience to a law; I know that vigilant individual care and intelligent appreciation of the interests of their children would, as a consequence, have slowly grown to be a part of their character. How can these things ever grow into being, if by a compulsory law you make them as regards each special case in turn unnecessary? Did anything in this world ever come into being if you had rendered its growth superfluous? What is it that develops all the best qualities of human nature? Simply the pressure upon us of those natural pains

and penalties that follow the absence of these qualities; then the intelligent perception that we are meant for our happiness to have these qualities; then the moral attachment to these qualities that is developed as we struggle to have them. But how can any of these things be if you step in between the man and Nature's way of teaching him with your hasty and ill-advised compulsions? The parent's treatment of the child, as regards his labor, had been both to parent and child an ever-growing, an ever-widening education, if you had had a little more patience as regards learning Nature's ways, and a little less arrogance as regards your own methods.

And now see to-day the second chapter that is already following on the first. Over a long series of years we have been congratulating ourselves upon the philanthropy of these acts and their excellent effect upon the people. A universal system of national education accompanied with compulsion has succeeded to the acts as their logical complement; and now to-day—thanks to the efforts of a few discerning people who have not simply followed a fashion in this matter—we wake to find that we are applying this system in such a hasty and reckless manner that we are injuring the very brains and bodies that we intended to benefit. Of course, the responsible office can not see the mischief—what public office ever did see or understand the more remote and less direct consequences of its actions? Of course, the great mass of parents that have let the education and management of their children slip practically out of their hands, that have measured their duties by an official regulation, that have allowed a group of worthy gentlemen at Whitehall to think and act for them, and have accepted so much public cash for thus morally effacing themselves, that, in a word, are drowsing while others care for and control the very greatest of their interests, have, just so far as they have done this, disqualified themselves from exercising a wise and intelligent discernment as to where the true loss and the true gain lie. How can it be otherwise? All great state systems stupefy. Without dwelling upon the oppressive uniformity; the sacrifice of some to others, and of all to official mediocrity; the stiff wooden parts; the pedantries and complexities that accompany all attempts at official nursing of a nation; the hard and fast regulations that turn grants of public money into a curse and not a blessing; the moral deterioration that results from marrying together one of the noblest of all desires, that of gaining more knowledge, with the meanest of all precautions, "Let us do it at the public expense"—leaving all this out of consideration, the one great fact remains, sufficient in itself to damn the whole thing, that where you have a national and uniform system, there you necessarily have two political parties struggling for its management and blotting out all individual choice and perception by the discipline—in an intellectual sense the brutalizing discipline—that each party for the sake of defeating its opponent learns to submit to. All discipline for fighting pur-

poses brutalizes in this sense. It deprives men of more than half their perceptions. And so it comes naturally about that, having adopted the very best means to make ourselves thoroughly stupid about education—first, by factory acts, and then by their logical completion, a universal state system—we now find ourselves face to face with dangers, the very possibility of which, in our hurry to manufacture intelligence by state machinery, had never occurred to us. But this frightful and almost immeasurable evil of over-pressure, which is certainly not going to be charmed out of existence by any number either of indignant or persuasive minutes written with an undisguised odor of office about them by my friend Mr. Fitch, is not the only sign that you can not make the state a parent without the logical consequence of making the people children. Some years ago we were startled by the reports of the ill-adapted food on which children in certain parts of the manufacturing districts were fed, or rather were not fed; we were startled by the high death-rate of very young children in certain towns. Yet we might have known it would be so. These are the necessary fruits of all such legislation as that of factory acts or of state education and compulsion, which forces on parents a certain view of their duty instead of leaving them, slowly and painfully though it may be, to learn it intelligently for themselves. Official regulation and free mental perception of what is right and wise do not and can not co-exist. I see no possible way in which you can reconcile these great state services and the conditions under which men have to make true progress in themselves. At least, if you are to do so, you must first get rid of certain great facts in nature. At present we live under the condition which, unfortunately, seems likely to last our time or a little longer, that no great human qualities are developed where you take away the opportunities for their development, that they do not grow spontaneously and without pressure, that each action by which for the moment the good and the bad are placed on the same level—for example, the selfish and the unselfish parent, or the drunkard and the sober man—tends to delay the emergence of the better type out of the inferior type. Every such kind of action relieves the unworthy of the consequences of their actions, and takes from the worthy the occasions of acquiring, and preserving, and strengthening those qualities that are good and useful. In a word, so far as you are able to do it for the moment, you make goodness unnecessary; and as unfortunately the world was constructed on a plan which makes goodness an essential element in obtaining happiness, you are trying to go by one road while Nature is trying to go by another. My two friends, Mr. Mundella and Sir W. Lawson, both of them against their will architects of national incapacity, may quarrel with my verdict on their work, but, quarrel or not, they are both doing their best—the one to make temperance and the other to make the intelligent care of parents for their children an unnecessary part of human nature. They are both throwing all the

power and influence that are in their hands on the side of the inferior type; they are both, so far as they can do it, preventing the development of the better type. They are both manufacturing virtues which are the mere imitations of virtues, sham products that, as time will tell them, will neither wash nor wear. Many men before them have tried a fall with Nature and her conditions, and have scarcely had the best of it. Nature in her irony often allows us a ten minutes of seeming success when we go against her methods, and I doubt not that both Sir W. Lawson and Mr. Mundella will have a ten minutes of their own; but then comes the after-time in which the bent bow flies back. I hope as it does so it may not hit any of my friends too violently in the face who have been so strenuously bending it down.

BLOODY SWEAT.

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THIS rare affection, which has always excited in a high degree the interest and attention of medical observers, consists essentially of a hæmorrhage from the unbroken surface of the skin. But, inasmuch as it takes place from the net-work of small vessels which surround the sweat-glands, and makes it appearance through the opening of the sweat-ducts, it is not inappropriately, after all, named "bloody sweat."

The discharge is generally intermittent, or at least remittent, and paroxysmal in its nature, the intervals varying from a few hours to months. Sometimes it is pure blood which coagulates in crusts or gouts upon the surface, sometimes it is so intermixed with serum or the perspiratory fluid as to be merely a more or less deeply colored bloody liquid.

Its extent varies extremely: it may make its appearance over the whole or nearly the whole of the surface of the body, but more commonly it is confined to some selected regions, generally those in which the skin is thin and delicate. It most frequently appears as a more or less copious and continued oozing from the surface, which, when wiped away, rapidly or slowly reappears from numerous minute or indistinguishable points, but it has been seen to spring up in a distinct jet from the surface.

It is often associated with eruptions upon the skin, but quite as often there is nothing of the kind. Every age and both sexes have furnished examples of it, though it is most common in females, and especially in nervous and hysterical women. Bloody sweat may be pro-

duced by overwhelming mental emotions, and marks the acme of such perturbing passions as terror, anguish, despair, etc.

In these cases and some others it appears to be the result of a purely nervous impression; while in still others, as in malarial fevers, of which it has been known to form a complication, the immediate cause is of a somewhat different nature. While in some cases it has been associated with scurvy, purpura, and other blood-diseases, this has not generally been the case. It has been simulated chiefly by enthusiastic and dishonest pietists.

Examples of the affection may be found extending throughout the whole range of medical literature, as well modern as ancient, and from a study of these we shall best be able to bring into view its numerous and varying phases.

The eminent French historian De Thou mentions the case of an Italian officer who commanded at Monte-Maro, a fortress of Piedmont, during the war in 1552 between Henry II of France and the Emperor Charles V. This officer, having been treacherously seized by order of the hostile general, and threatened with public execution unless he surrendered the place, was so agitated at the prospect of an ignominious death that he sweated blood from every part of his body.

The same writer relates a similar occurrence in the person of a young Florentine at Rome, unjustly put to death by the order of Pope Sixtus V, in the beginning of his reign, and concludes the narration as follows: "When the youth was led forth to execution, he excited the commiseration of many, and through excess of grief was observed to shed bloody tears, and to discharge blood instead of sweat from his whole body—a circumstance which many regard as a certain proof that Nature condemned the severity of a sentence so cruelly hastened, and invoked vengeance against the magistrate himself, as therein guilty of murder."

Among several examples, given in the German "Ephemerides," of bloody tears and bloody sweat occasioned by extreme fear, more especially the fear of death, may be mentioned that of "a young boy who, having taken part in a crime for which two of his elder brothers were hanged, was exposed to public view under the gallows on which they were executed, and was thereupon observed to sweat blood from his whole body."

It is mentioned by Theophrastus, and by Aristotle, who says, "Some have a bloody sweat," and again, "Some through an ill habit of body have sweat a bloody excrement."

And Diodorus Siculus says of the Indian serpents that, if any one be bitten by them, he is tormented with excessive pains, and seized with a bloody sweat. Galen observes, "Contingere interdum poros ex multo aut fervido spiritu adeo dilatari, ut etiam exeat sanguis per eos fiatque sudor sanguineus" (Sometimes the pores become so much dilated by rapid or fervid breathing that the blood oozes out

through them, and is made a bloody sweat); while Lucan thus describes it:

> " . . . Sic omnia membra
> Emisere simul rutilum pro sanguine virus.
> Sanguis erant lacrymae; quacumque foramina novit
> Humor, ab his largus manat cruor; ora redundant,
> Et patulae nares; sudor rubet; omnia plenis
> Membra fluunt venis; totum est pro vulnere corpus."

(Thus all the limbs together emitted a red humor the same as blood. The tears were blood; and whatever openings the humor knew, from them flows copious bleeding; the mouth and the distended nostrils overflow; the sweat is red; the veins flow full in all the limbs; the whole body is as if it were a wound.)

The detestable Charles IX of France sank under this disorder, thus described by Mezeray ("Histoire de France," vol. iii, p. 306): "La nature fit d'étranges efforts pendant les deux dernières semaines de la vie de la roi. Il s'agitait et se remuait sans cesse; le sang lui rejalliait par les pores et partout les conduits de son corps. Après avoir long-temps suffert, il tomba dans une extreme faibleur et rendit l'âme." (Nature made strange efforts during the last two weeks of the life of the king. He was in constant agitation and motion; the blood gushed out from his pores and from all the conduits of his body. After having suffered a long time, he fell into an extreme weakness and gave up his soul.) The same historian relates the case of the governor of a town taken by storm, who was condemned to die, and was seized with a profuse sweating of blood the moment he beheld the scaffold. Lombard mentions a general who was affected in a similar manner on losing a battle. The same writer tells us of "a nun who was so terrified when falling into the hands of ruthless banditti that blood oozed from every pore." (Schenck, apparently referring to the same case, says that she died of the hæmorrhage, in the sight of her assailants.)

Henry ab Heer records the case of a man who not only labored under bloody sweat, but small worms also accompanied the bloody secretion. These were undoubtedly vermicular or worm-like coagula, or clots, formed in the sweat-ducts.

In the memoirs of the Society of Arts of Haarlem we read of the case of a sailor, who, falling down during a storm, was raised from the deck streaming with blood. At first it was supposed that he had been wounded, but on close examination the blood was found to flow from the surface of the body.

Fabricius de Hilden mentions a case that came under the observation of his friend Sporlinus, a physician of Bale: the patient was a child twelve years of age, who never drank anything but water; having gone out into the fields to bring home his father's flocks, he stopped upon the road, and, contrary to habit, drank freely of white wine. He shortly after was seized with fever. His gums first began to

bleed, and soon after a hæmorrhage broke out from every part of the integuments, and from the nose. A case is also related of a widow, forty-five years of age, who had lost her only son. She one day fancied that she beheld his apparition beseeching her to relieve him from purgatory by her prayers, and by fasting every Friday. The following Friday, in the month of August, a perspiration tinged with blood broke out. For five successive Fridays the same phenomenon appeared. The blood escaped from the upper part of the body, the back of the head, the temples, the eyes, the nose, the breast, and the tips of the fingers. The disorder disappeared spontaneously on Friday, the 8th of March in the following year.

This affection was evidently occasioned by superstitious fears; and this appears more probable from the periodicity of the attacks. The first invasion of the disease might have been purely accidental; but the regularity of its subsequent appearance on the stated day of the vision may be attributed to the influence of apprehension. Bartholinus mentions cases of bloody sweat taking place during vehement terror, and the agonies of torture.

The case of Catherine Merlin, of Chamburg, is well authenticated, and worthy of being recorded. She received a kick from a bullock over the pit of the stomach, that was followed by vomiting of blood; this discharge having been suddenly stopped by her medical attendants, the blood made its way through the pores of various parts of her body, every limb being affected in turn. The sanguineous discharge was preceded by a pricking and itching sensation. The discharge usually occurred twice in the twenty-four hours; and on pressing the skin the flow of blood could be accelerated and increased. Dr. Fournier relates the case of a magistrate who was attacked with bloody sweat after any excitement, whether of a painful or a pleasurable nature.

In his "Commentaries on the Four Gospels," Maldonato refers to a robust and healthy man at Paris, who, on hearing sentence of death passed on him, was covered with a bloody sweat. Zacchias mentions a young man who was similarly affected on being condemned to the flames. The following case is quoted, in the "Medico-Chirurgical Review," from the French "Transactions Médicale" for November, 1830: A young woman, aged twenty-one years, of indolent habits and obstinate temper, had been much irritated by some reflections made by her parents on account of her abjuring the Protestant religion. She left the parental roof, and, after wandering about for some time, took up her residence in a hospital. She was then suffering from violent attacks of hysteria, attended with general convulsions. After paroxysms of hysteria, which sometimes lasted twenty-four or thirty-six hours, this young woman fell into a kind of ecstasy, in which she lay with her eyes fixed, sensibility and motion suspended. Sometimes she muttered a prayer, but the most remarkable phenomenon was an exudation of

blood from the cheeks and the surface of the abdomen in the form of perspiration. The blood exuded in drops, and tinged the linen. This bloody perspiration took place whenever the hysteric paroxysm lasted a considerable time.

J. C. Schilling relates the case of a boy, twelve years of age, who was relieved from a severe comatose and convulsive disorder by a bloody sweat which broke out August 2, 1747.

The following note on this subject is from Dr. Schneider, a celebrated German physician: He mentions having been once summoned to a healthy man, fifty years of age, who, for a period of twelve months in succession, had traveled on foot; during the journey he had perspired much in his feet; and, on examining them at the end of it, they were found covered as high as the ankles with a sanguineous perspiration, which had also soaked into and stained his stockings. He quotes, among others, the following remarkable case from Paulini: While surgeon on board a vessel, a violent storm arose, and threatened immediate destruction to all. One of the sailors, a Dane, thirty years of age, with fair complexion and light hair, was so terrified that he fell speechless on the deck. On going to him, Paulini observed large drops of perspiration of a bright-red color on his face. At first, he imagined the blood came from the nose, or that the man had injured himself by falling; but, on wiping off the red drops from his face, he was astonished to see fresh ones start up in their place. The colored perspiration oozed out from different parts of the forehead, cheeks, and chin; but was not confined to these parts, for, on opening his dress, he found it formed on the neck and chest. On wiping and carefully examining the skin, he distinctly observed the red fluid exuding from the openings of the sweat-ducts. So deeply stained was the fluid that, on taking hold of the handkerchief with which it was wiped off, the fingers were made quite bloody. As the bloody perspiration ceased, the man's speech returned; and when the storm passed over he recovered, and remained quite well during the rest of the voyage.

Erasmus Wilson, in his work on "Diseases of the Skin," mentions two cases which had come under his own observation, and refers to three others. M. Du Gard has recorded the case of a child three months old that was taken with bleeding at the nose and ears, and on the hinder part of the head, which lasted for three days, and afterward the nose and ears ceased bleeding, but still the blood-like sweat came from the head. Three days before the death of the child, which happened the sixth day after it began to bleed, the blood came more violently from its head, and streamed out to some distance. It also bled on the shoulders and at the waist; and for three days at the toes, at the bend of its arms, at the joints of the fingers, and at the finger-ends.

Dr. John Mason Good remarks that ephidrosis cruenta, which he

defines as cutaneous perspiration intermixed with blood, has taken place during vehement terror, and not unfrequently during the agony of hanging, or the torture. It is said, also, in some instances, to have occurred in new-born infants, probably from the additional force given to the circulation in consequence of a full inflation of the lungs, accompanied with violent crying.

The following remarkable case is related by Hebra, in his work on "Diseases of the Skin": "The patient was a young man, strong and well-nourished, who was attacked repeatedly by hæmorrhage from the surface of the lower limbs. This generally occurred during the night, so that he first became aware that the bleeding had taken place by finding the sheets stained with spots of blood when he awoke. I once, however, saw blood flow from the uninjured back of the hand of this patient while he was sitting near me at table. The blood formed a jet, which would about correspond in size to the duct of a sweat-gland. This jet had also a somewhat spiral form, and rose about one line above the surface of the skin." An exceedingly interesting case was reported by Dr. Hart, in the "Richmond and Louisville Medical Journal," January, 1875, p. 98.

The most recent case that I have found is the following from an informal "Report of the Proceedings of the King William County (Virginia) Medical Association," by George William Pollard, M. D., and published in the "Virginia Medical Monthly" for January, 1880, p. 816: "Among a number of interesting cases reported at the last meeting of the King William County Medical Association, was one by Dr. R. G. Hill, of bloody sweat, the subject being a boy four years of age, suffering from malarial fever.

"During each sweating stage, blood oozed from the face and neck. Febrifuges followed by quinine afforded relief; but two months later he was taken with hæmorrhage from the bowels. This condition was accompanied with vomiting of blood, from which he died."

I have been able to collect in all forty-seven cases of this strange and interesting disorder; and, when we consider the long period over which this research extends and the tolerable certainty that every case of this kind has found its way into print, this number may surely be received as an indication that it is extremely rare. One of the lower animals, the hippopotamus, sweats blood, at least when brought to this country and kept in a state of confinement, as I myself have witnessed; the instance thus seen occurred during hot weather in the latter part of summer.

As already stated, sweating of blood has been simulated by religious enthusiasts, the following instructive example of which is taken from Hebra: "More than ten years ago there lived in a village not far from Vienna a woman who was said to take neither food nor drink, and who asserted that every Friday, between the hours of 10 A. M. and noon, hæmorrhage occurred spontaneously from her skin at

various points, but especially from her face, feet, and hands. The parts were, in fact, said to be the same from which blood flowed during the crucifixion of our Lord. Now, as this occurrence created a great sensation in the neighborhood, and attracted numerous pilgrims from all parts of the country, the authorities found themselves compelled to make a thorough investigation of the matter. Dr. Haller, a physician who held a high position in the General Hospital at Vienna, was sent to the spot, with the necessary staff of police, in time to place the woman under surveillance on a Thursday, and to bring her before the Friday to Vienna. Here she was placed in a room, so that she could be watched uninterruptedly night and day, by medical men. The Friday came, and the woman did not bleed. She, however, took nothing that day nor till the evening of Saturday, when, tormented by hunger, she asked for food, and ate a considerable quantity. From this time she took nourishment regularly, and the hæmorrhage never returned. The case just related is probably similar to not a few others which are recorded in the history of spontaneous hæmorrhages (under the name of stigmata, etc.), but which were never brought into the clear light of scientific investigation, so as to be examined without prejudice and—*explained*."

These impostors, the so-called stigmata, still make their appearance from time to time in Catholic countries, as is shown by a cheap publication evidently intended for circulation among the ignorant faithful, which I recently came across, and which has the following extended title-page: "Letter from the Earl of Shrewsbury to Ambrose Lisle Philips, Esq., descriptive of the Ecstatica of Caldasa, and the Addolorato of Caspiana; being a second edition, revised and enlarged; to which is added the Relation of Three Successive Visits to the Estatica of Monte Sansavino, in May, 1842. First American, from the last revised London edition; with Additional Letters now first published; bringing the Narrative down to 1842. '*It is honorable to reveal and confess the works of God*' (Tobias xii, 7). New York, 1843."

In this publication fifty similar cases are adduced, which are said to have received the attestation of the Church. Of those with which the book itself is concerned, one is said to eat nothing but a little fruit; of another it is asserted: "Indeed, she may be truly said to subsist upon air; for, on the 15th of August next, it will be *eight years complete since she ate, drank, or slept!*" (Where is Dr. Tanner after this?)

It is a noteworthy fact that these cases were all those of poor peasant-girls, in secluded, out-of-the-way hamlets, among a rustic and ignorant population; they were plainly hysterical and cataleptic, visited by hundreds of wondering, half-adoring spectators, who were ready to fall down and worship them. We have here everything that could stimulate and aid deception, and nothing at all of

the "clear light of scientific investigation" to which Hebra's case was subjected.

With regard to the so-called bloody sweat of our Saviour, such an undoubted article of faith to many, and so familiar to our ears in the pathetic invocation of the Litany of the Episcopal Church, "By thine agony and bloody sweat," the once celebrated Dr. Mead makes the following observations in his "Medica Sacra": "Saint Luke relates of Christ himself that, when he was in an agony by the fervency of his prayers, his sweat was like drops of blood falling down on the ground. This passage is generally understood as if the Saviour of mankind had sweated real blood. But the text does not say so much. The sweat was only *hosoi thromboi* AIMATOS, as it were, or like drops of blood; that is, the drops of sweat were so large, thick, and viscid, that they trickled to the ground like drops of blood. Thus were the words understood by Justin Martyr, Theophylactus, and Euthymius."

Beza's Latin Testament renders the words, "Erat autem sudor ejus quasi grumi sanguinis descendentes in terram." (But his sweat was as drops of blood falling upon the earth.)

Luther's German version has, "Es ward aber sein Schweisz wie Blutstropfen die fielen auf die Erde." (But his sweat was as drops of blood that fell upon the earth.)

The Rhemish Testament, from the Vulgate of Jerome, gives in the translation recognized by the Catholic Church in this country, "And his sweat became as drops of blood trickling down upon the ground."

Our authorized version, "And his sweat was as it were great drops of blood falling down to the ground."

The recent revision changes only a single word, making it, "And his sweat became as it were great drops of blood falling down upon the ground."

Among modern commentators some agree with Whitby, who says, "I own that these words do not certainly signify that the matter of this sweat was blood, but only that it was like to blood, being in such large drops." But the majority hold with Alford, that it was a veritable bloody sweat.

Adam Clarke contends that the passage must be interpreted according as the emphasis is made to rest on *thromboi*, or *aimatos*, and unhesitatingly declares for the latter.

Perhaps it would be better not to add anything to the judicious and non-committal remarks of Dr. Mead, but still I will hazard the following considerations: It is difficult to understand why, if Luke, a clear writer and said to be a physician, wished to state the fact of a bloody sweat, he could not have done so in plain, straightforward language, with no ambiguity about it. If he was, as it is said, a physician, the simile of dropping blood, not an unnatural one in any case for profuse sweat, would be all the more natural and likely to be used.

In the gloom of the garden the color would not be noticed, though the profuseness of the sweat, as its falling proved, might; furthermore, if it had been blood it would have left stains, if not crusts or coagula behind it, and excited still further notice and remark. From all these considerations I think we have reason enough to conclude that this case of bloody sweat exists only in the affectionate and pious fancy of the Church—come down to us from the former ages, when men would rather believe than examine, and left undisturbed even to these times, when, alas! men would, as a rule, rather examine than believe.

PROTECTIVE MIMICRY IN MARINE LIFE.

By Dr. WILHELM BREITENBACH.

BY mimicry we understand the assumption by animals of a deceptive similarity answering a protective purpose, not only to other animals, but also to lifeless objects, and, in color, to the surroundings. In a biological application, this definition of the term, though different from the common one, is well founded; for similarity of an animal with any object affords it protection, by enabling it to approach its prey unobserved; by facilitating its escape from enemies; or by shielding it, under cover of its resemblance to unpleasant objects, from hostile attacks. A number of observations have been published, by various well-known authors, upon the interesting phenomena of mimicry, but they have related generally to land animals, while the cases of the occurrence of similar phenomena among the inhabitants of the sea have been less extensively noticed. A few have been mentioned by Haeckel and Carus Stern, but I have others, of not less high interest, to describe.

On my voyage from Brazil to England in July, August, and September, 1883, I had many opportunities to secure and examine closely specimens of pelagic life. From the 30th of August to the 5th of September, we crossed the Sargasso Sea, between latitude 25° 12′ and 34° 39′, and longitude 33° 52′ and 35° 52′ west. The sea-weeds were not massed in extensive fields, but were distributed in single groups of larger or smaller size, and these were driven by the wind in nearly straight lines, that could be followed with the eye to considerable distances. The linear arrangement was also made distinct to me by its pelagic life, particularly by its great colonies of radiolaria, or polycyttaria, salpæ, and other orders. Thus, I find in my notes such items as, "September 3d, polycyttaria in colossal masses, thick, wide bands of them stretching along for miles; September 14th, immense masses of little salpæ and polycyttaria, causing the water to display milky bands."

I did not neglect to fish up masses of the Sargasso sea-weed every

day and examine it through and through for its fauna, and whenever I did this I found many notable cases of mimicry. The color of the younger plants is a yellowish green, while the older stalks are of a more or less dark brown. A luxuriant animal life flourishes on the stems, leaves, and air-vessels of the Sargasso-weed. Little actiniæ, sometimes of a light, sometimes of a dark-brown color, were very numerous on the plants I most closely examined; often so thick as to completely cover the stems. On the same plants, I also found numerous specimens of small, naked snails. These minute gasteropods, a centimetre or a centimetre and a half long, bore on their backs numerous retractile tentacles, arranged in cross-rows at various intervals. In color, they were of various shades of brown, like the actiniæ; when they drew themselves up so that the tentacles stood thickly together, they so much resembled the actiniæ that it would be a matter of difficulty to a person not acquainted with both animals to tell them apart. Another snail, whose tentacles were arranged in rows along each side of the back, was still more difficult to distinguish when any danger threatened it from the actiniæ. Of what use can the resemblance to the actiniæ be to the little mollusks? They are, it is true, great eaters of the actiniæ, for I have seen one of them devour four or five of those animals in an hour; but it does not appear that their access to them is greatly facilitated by the resemblance, for the actiniæ are so confined by the limitation of their movements as to be unable, in any case, to escape their more facile enemies. We are, therefore, reduced to consider the likeness a case of mimicry for the protection of the snails against animals which pursue them, but avoid the actiniæ, whose nettle-cells are by no means pleasant morsels. But as I have not been able to discover what special enemies the snails have, and whether they really dislike the actiniæ, my attempted explanation must remain an attempt, to be confirmed or disproved by some future observer in the Sargasso Sea, who can begin where I have had to leave off. Other cases of mimicry on the part of mollusks have come under observation. According to Dr. H. von Ihering, the *Chromodoris gracilis* lives associated with a sponge (*Suberites*), and is colored like it, blue.

On the same sea-weed I found other larger mollusks, which, not resembling other animals, so strikingly resemble the forms of the stems and leaves of the plants that it is extremely difficult to find them in the tangle of brush. They have developed flaps all around their bodies, before and behind, and on either side, the edges of which are irregularly serrated, with the tips of the serratures of a brown tint like the older alga-stems. The surface of the flaps, and of a part of the rest of the body, is beset with numerous small similarly brown-tipped teeth, while the color of the animal as a whole is olive-green, like that of the plant in which it lives.

Moritz Wagner regards the phenomena of mimicry as the consequence of an innate caution in the animal, that causes it to choose those

places for its abode with which it most corresponds in color. Dwelling on this point, he remarks that "the instinct of self-preservation native to all animals, which sharpens their senses against incessantly threatening dangers, prompts marine as well as land animals to seek dwelling-places similar to themselves in form and color." Any person who has had opportunity, as I have, to watch the little crabs and shrimps, that swim around in the alga-groups of the Sargasso Sea, for half a day at a time, will have to admit that there is much in this view, though it will not be necessary to throw away the theory of selection. I can not say whether the crab I have observed is the same that Wagner describes as *Nautilo graspus minutus*. I have collected several hundreds of the animals, and think, after superficial observation, that I can distinguish more than one species among them, while the variability, especially in color, is wonderful. The adaptation of the innumerable tints to every grade of change in the color of the sea-weed is really marvelous. The younger, lighter green crustaceans are always to be found on the young, verdant fronds of the plant, while the older parts of the weed are inhabited by older, brown animals. The older stems are often incrusted with the white shells of bryozoa, and corresponding with these we are sure to find white spots on the brown armor of the crabs. The legs of the animals are frequently of an olive-green ground with brownish spots, deceptively like the slender sea-weed-leaves that are just beginning to turn brown. If one will, as I did, pull one of the large plants upon the deck, leave it in a cask of sea-water for an hour or two, and then look through it for crabs without disturbing it, he will find it very hard to discover three or four of the animals, although he may be sure there are a quarter of a hundred of them there; and, if he gives the mass a lively shake, he will find a curious assemblage of the most varied sorts tumbling off the bush, whose behavior will go far to verify Wagner's view; for, if they are allowed the opportunity, they will all swim back to the sea-weed, and each will seek a part of the plant most like it in color. I tried the experiment forty or fifty times, and never saw a little green crab settle on a dark-brown stem. The crustaceans keep to their color, and the brown ones will, with amazing speed, dart through the thick net-work of stems and leaves, to the darkest spot they can find, where they quickly escape observation.

I remarked another striking example of what might be considered intelligent mimicry in a crab, on the 11th of September, after we had got out of the Sargasso Sea. Toward night a piece of dark-brown bark, about as large as one's hand, floated close by the ship. Thinking I might find something upon it, I fished it up with a scoop I had prepared for such purposes and which I had found very useful, and put it in a pail of fresh sea-water for observation. While I stood looking at it, I perceived motions of legs and tentacles, and then discovered a crab, so precisely of the color of the bark, that it might have lain on

it a long time, had it not moved, before I would have noticed it. I called the attention of the captain of the ship to the object, and he examined it for some minutes, the crab not moving, before he saw anything but bark. How came this brown crab, on a piece of wood of precisely the same color, in the middle of the ocean? Must we believe that several crabs got on the bark, among them the brown one, and that the struggle for existence resulted in his being the only one left? I am satisfied that we can come to no other conclusion than Wagner's, and that we must believe that a conscious or perhaps an instinctive choice governed the animal in settling upon an object so like it in color. The bark was probably occupied while floating among the sea-weed, then drifted away to the spot where it was found, and where it furnished so singular an isolated example of selective mimicry. I found numerous slender fishes in the algæ of the Sargasso Sea, likewise protected by their resemblance in color to the plants among which they lived. One afternoon, after I had examined a plant for an hour for crabs, I took it out of the pail to throw it into the sea, when a fish about the size of a lead-pencil fell out of it. I put the fish into another pail, in which there was also a sea-weed. It instantly vanished from my sight, and I had to look for some time among the thick stems before I could find it again.

I do not know whether any of these observations have been recorded before. During my residence in Brazil, I had but limited opportunities to keep acquainted with recent zoölogical literature. But I found my sail through the Sargasso Sea full of interest, and I believe that a voyage there would be fraught with pleasure and profit to every naturalist. It is not so very expensive, either; and can easily be made on a schooner or bark sailing from a European port to the West Indies. My passage from Porto Allegro in Southern Brazil, to Falmouth, England, from the 15th of June to the 25th of September, cost me, board included, less than seventy-five dollars. Such a voyage furnishes, moreover, at the same time, an opportunity to make a personal acquaintance with the natural history of tropical regions.—*Translated for the Popular Science Monthly from Kosmos.*

THE CHEMISTRY OF COOKERY.

BY W. MATTIEU WILLIAMS.

XLII.—STIMULANTS AND CONDIMENTS.

BEFORE proceeding further, I must fulfill the promise made in No. 39 to report the results of my repetition of the Indian process of preparing *samp*. I soaked some ordinary Indian corn in a solution of carbonate of potash, exceeding the ten or twelve hours

specified by Count Rumford. The external coat was not removed even after two days' soaking, but the corns were much swollen and softened. I suspect that this difference is due to the condition of the corn which is imported here. It is fully ripened, dried, and hardened, while that used by the Indians was probably fresh gathered, barely ripe, and much softer.

Mr. Gaubert (No. 1,373, page 185) asks me whether I think that tea taken in moderation (say two cups in the evening) does any mischief. If he carefully reads No. 40, he will find the answer already given before his question was asked. He offers to relinquish the habit, in spite of the pang, "on the advice of so eminent an authority" as myself. I hope that he will not be so weak as to accept my authority or any other on a question which can easily be answered by common sense and simple direct experiment. There are cases in which we are compelled to lean on authority, but this is not one of them, and he will see, by reperusing what I have written on the subject, that I have repudiated mere authority, and appealed to facts that are open to all.

I will reply further to Mr. Gaubert, as in doing so I shall be also replying to a multitude of others, his case being typical. Let any of these repeat the experiment that I have made. After establishing the habit of taking tea at a particular hour, suddenly relinquish it altogether. The result will be more or less unpleasant, in some cases seriously so. My symptoms were a dull headache and intellectual sluggishness during the remainder of the day—and if compelled to do any brain-work, such as lecturing or writing, I did it badly. This, as I have already said, is the diseased condition induced by the habit. These symptoms vary with the amount of the customary indulgence and the temperament of the individual. A rough, lumbering, insensible navvy may drink a quart or two of tea, or a few gallons of beer, or several quarterns of gin, with but small results of any kind. I know an omnibus-driver who makes seven double journeys daily, and his "reg'lars" are half a quartern of gin at each terminus—i. e., $1\frac{3}{4}$ pint daily, exclusive of extras. This would render most men helplessly drunk, but he is never drunk, and drives well and safely.

Assuming, then, that the experimenter has taken sufficient daily tea to have a sensible effect, he will suffer on leaving it off. Let him persevere in the discontinuance, in spite of brain-languor and dull headache. He will find that day by day the languor will diminish, and in the course of time (about a fortnight or three weeks in any case) he will be weaned. He will retain from morning to night the full, free, and steady use of all his faculties; will get through his day's work without any fluctuation of working ability (provided, of course, no other stimulant is used). Instead of his best faculties being dependent on a drug for their awakening, he will be in the condition of true manhood—i. e., able to do his best in any direction of effort, simply in

reply to moral demand; able to do whatever is right and advantageous, simply because his reason shows that it is so. The sense of duty is to such a free man the only stimulus demanded for calling forth his uttermost energies.

If he again returns to his habitual tea, he will again be reduced to more or less of dependence upon it. This condition of dependence is a state of disease precisely analogous to that which is induced by opium and other drugs that operate by temporary abnormal cerebral exaltation. The pleasurable sensations enjoyed by the opium eater or smoker or morphia-injector are more intense than those of the tea-drinker. Mr. Gaubert tells us that he enjoys his cup "immensely." The gin-drinker enjoys his half quartern "immensely," as anybody may see by "standing treat" and watching the result. The victim of opium has enjoyment still more immense, and in every case the magnitude of the mischief is measurable by the immensity of the enjoyment.

Again I say that I am not denouncing the proper use of any of these things. There are occasions when artificial stimulants or sedatives cautiously used are most desirable. My condemnation is applied to their *habitual* use, and the physical and moral degradation involved in the slavish dependence upon any sort of drug, especially when the drug operates most powerfully on the brain. To the brain-worker tea is worse than alcohol, because it exaggerates his special liability to overstrain. I can detect by physiognomical indications the habitually excessive tea-drinker as readily as I can detect the physiognomy of the opium-victim, as may anybody else who chooses to make careful observations.

I must not leave this subject without a word or two in reference to a widely prevailing and very mischievous fallacy. Many argue and actually believe that, because a given drug has great efficiency in curing disease, it must do good if taken under ordinary conditions of health.

No high authorities are demanded for the refutation of this. A little common sense properly used is quite sufficient. It is evident that a medicine, properly so called, is something which is capable of producing a disturbing or alterative effect on the body generally or some particular organ. The skill of the physician consists in so applying this disturbing agency as to produce an alteration of the state of disease, a direct conversion of the state of disease to a state of health, if possible (which is rarely the case), or more usually the conversion of one state of disease into another of milder character. But, when we are in a state of sound health, any such disturbance or alteration must be a change for the worse, must throw us out of health to an extent proportionate to the potency of the drug.

I might illustrate this by a multitude of familiar examples, but they would carry me too far away from my proper subject. There is,

however, one class of such remedies which are directly connected with the chemistry of cookery. I refer to the condiments that act as "tonics," excluding common salt, which is an article of food, though often miscalled a condiment. It is food simply because it supplies the blood with one of its normal and necessary constituents, chloride of sodium, without which we can not live. A certain quantity of it exists in most of our ordinary food, but not always sufficient.

Cayenne pepper may be selected as a typical example of a condiment properly so called. Mustard is a food and condiment combined; this is the case with some others. Curry-powders are mixtures of very potent condiments with more or less of farinaceous materials, and sulphur compounds, which, like the oil of mustard, of onions, garlic, etc., may have a certain amount of nutritive value.

The mere condiment is a stimulating drug that does its work directly upon the inner lining of the stomach, by exciting it to increased and abnormal activity. A dyspeptic may obtain immediate relief by using cayenne pepper. Among the advertised patent medicines is a pill bearing the very ominous name of its compounder, the active constituent of which is cayenne. Great relief and temporary comfort are commonly obtained by using it as a "dinner-pill." If thus used only as a temporary remedy for an acute and temporary, or exceptional, attack of indigestion, all is well, but the cayenne, whether taken in pills or dusted over the food or stewed with it in curries or any otherwise, is one of the most cruel of slow poisons when taken *habitually*. Thousands of poor wretches are crawling miserably toward their graves, the victims of the multitude of maladies of both mind and body that are connected with chronic, incurable dyspepsia, all brought about by the habitual use of cayenne and its condimental cousins.

The usual history of these victims is that they began by overfeeding, took the condiment to force the stomach to do more than its healthful amount of work, using but a little at first. Then the stomach became tolerant of this little, and demanded more; then more, and more, and more, until at last inflammation, ulceration, torpidity, and finally the death of the digestive powers, accompanied with all that long train of miseries to which I have referred. India is their special fatherland. Englishmen, accustomed to an active life at home, and a climate demanding much food-fuel for the maintenance of animal heat, go to India, crammed, may be, with Latin, but ignorant of the laws of health; cheap servants promote indolence, tropical heat diminishes respiratory oxidation, and the appetite naturally fails. Instead of understanding this failure as an admonition to take smaller quantities of food, or food of less nutritive value, they regard it as a symptom of ill-health, and take curries, bitter ale, and other tonics or appetizing condiments, which, however mischievous in England, are far more so there.

I know several men who have lived rationally in India, and they all

agree that the climate is especially favorable to longevity, provided bitter beer, and all other alcoholic drinks, all peppery condiments, and flesh foods, are avoided. The most remarkable example of vigorous old age I have ever met was a retired colonel eighty-two years of age, who had risen from the ranks, and had been fifty-five years in India without furlough; drank no alcohol during that period; was a vegetarian in India, though not so in his native land. I guessed his age to be somewhere about sixty. He was a Scotchman, and an ardent student of the works of both George and Dr. Andrew Combe.

While still seasonable I add by way of postscript a receipt for a dish lately invented by my wife. It is vegetable marrow *au gratin*, prepared by simply boiling the vegetable as usual, slicing it, placing the slices in a dish, covering them with grated cheese, and then browning slightly in an oven or before the fire, as in preparing the well-known "cauliflower *au gratin*." I have modified this (with improvement, I believe) by mashing the boiled marrow and stirring the grated cheese into the midst of it while as hot as possible; or, better still, by adding a little milk, a pinch of bicarbonate of potash, mixing with the cheese, and then returning this *purée* to the saucepan, heating and stirring it there for a few minutes to effect the complete solution of the cheese. This dish is not so pretty as that *au gratin* browned in orthodox fashion, but is more digestible.

XLIII.—THE COOKERY OF WINE.

In an unguarded moment I promised to include the above in this series, and will do the best I can to fulfill the promise; but the utmost result of this effort can only be a contribution to the subject which is too profoundly mysterious to be fully grasped by any intellect that is not sufficiently clairvoyant to penetrate paving-stones and see through them to the interiors of the closely tiled cellars wherein the mysteries are manipulated.

I will first define what I mean by the cookery of wine. Grape-juice in its unfermented state may be described as "raw wine," or this name may be applied to the juice after fermentation. I apply it in the latter sense, and shall use it as describing grape-juice which has been spontaneously and recently fermented without the addition of any foreign materials, or altered by keeping, or heating, or any other process beyond fermentation. All such processes and admixtures which effect any chemical changes on the raw material I shall describe as cookery, and the result as cooked wine. When wine made from other juice than that of the grape is referred to it will be named specifically.

At the outset a fallacy, very prevalent in this country, should be controverted. The high prices charged for the cooked material sold to Englishmen has led to absurdly exaggerated notions of the original value of wine. I am quite safe in stating that the average market

value of rich wine in its raw state, in countries where the grape grows luxuriantly, and where, in consequence, the average quality of the wine is the best, does not exceed sixpence per gallon, or one penny per bottle. I speak now of the newly made wine. Allowing another sixpence per gallon for barreling and storage, the value of the commodity in portable form becomes twopence per bottle. I am not speaking of thin, poor wines, produced by a second or third pressing of the grapes, but of the best and richest quality, and, of course, I do not include the fancy wines, those produced in certain vineyards of celebrated châteaux, that are superstitiously venerated by those easily deluded people who suppose themselves to be connoisseurs of choice wines. I refer to the ninety-nine and nine tenths per cent of the *rich* wines that actually come into the market. Wines made from grapes grown in unfavorable climates naturally cost more in proportion to the poorness of the yield.

As some of my readers may be inclined to question this estimate of average cost, a few illustrative facts may be named. In Sicily and Calabria I usually paid, at the road-side or village "osterias," an equivalent to one halfpenny for a glass or tumbler holding nearly half a pint of common wine, thin, but genuine. This was at the rate of less than one shilling per gallon, or twopence per bottle, and included the cost of barreling, storage, and inn-keeper's profit on retailing. In the luxuriant wine-growing regions of Spain, a traveler, halting at a railway refreshment station and buying one of the sausage sandwiches that there prevail, is allowed to help himself to wine to drink on the spot without charge, but, if he fills his flask to carry away, he is subjected to an extra charge of one halfpenny. It is well known to all concerned that at vintage-time of fairly good seasons, in all countries where the grape grows freely, a good cask is worth more than the new wine it contains when filled; that much wine is wasted from lack of vessels, and anybody sending two good empty casks to a vigneron can have one of them filled in exchange for the other. Those who desire further illustrations and verification should ask their friends—*outside of the trade*—who have traveled in southern wine countries, and know the language and something more of the country than is to be learned by being simply transferred from one hotel to another under the guidance of couriers, cicerone, valets de place, and other flunkies. Wine-merchants are "men of business."

Thus the five shillings paid for a bottle of rich port is made up of one penny for the original wine, one penny more for cost of storage, etc., about sixpence for duty and carriage to this country, and twopence for bottling, making tenpence altogether; the remaining four shillings and twopence is paid for cookery and wine-merchant's profits.

Under cookery I include those changes which may be obtained by simply exposing the wine to the action of the temperature of an ordinary cellar, or the higher temperature of "Pasteuring," to be presently described.

In the youthful days of chemistry the first of these methods of cookery was the only one available, and wine was kept by wine-merchants with purely commercial intent for a considerable number of years.

A little reflection will show that this simple and original cookery was very expensive, sufficiently so to legitimately explain the rise in market value from tenpence to five shillings or more per bottle.

Wine-merchants require a respectable profit on the capital they invest in their business—say ten per cent per annum on the prime cost of the wine laid down. Then there is the rental of cellars and offices, the establishment expenses—such as wages, sampling, sending out, advertising, losses by bad debts, etc.—to be added. The capital lying dead in the cellar demands compound interest. At ten per cent the principal doubles in about seven and one third years. Calling it seven years, to allow very meagerly for establishment expenses, we get the following result:

					£	s.	d.	
When	7 years old	the tenpenny	wine is	worth	0	1	8	per bottle.
"	14	"	"	"	0	3	4	"
"	21	"	"	"	0	6	8	"
"	28	"	"	"	0	13	4	"
"	35	"	"	"	1	6	8	"

Here, then, we have a fair commercial explanation of the high prices of old-fashioned old wines; or of what I may *now* call the "traditional value" of wine.

Of course this is less when a man lays down his own wine in his own cellar in obedience to the maxim, "Lay down good port in the days of your youth, and when you are old your friends will not forsake you." He may be satisfied with a much smaller rate of interest than the man engaged in business fairly demands. Still, when wine thus aged was thrown into the market, it competed with commercially cellared wine, and obtained remarkable prices, especially as it has a special value for "blending" purposes, i. e., for mixing with newer wines and infecting them with its own senility.

But why do I say that *now* such values are traditional? Simply because the progress of chemistry has shown us how the changes resulting from years of cellarage may be effected by scientific cookery in a few hours or days. We are indebted to Pasteur for the most legitimate—I might say the only legitimate—method of doing this. The process is accordingly called "Pasteuring." It consists in simply heating the wine to the temperature of 60° C=140° Fahr., the temperature at which, as will be remembered, the visible changes in the cookery of animal food commences. It is a process demanding considerable skill; no portion of the wine during its cookery must be raised above this temperature, yet all must reach it; nor must it be exposed to the air.

The apparatus designed by Rossignol is one of the best suited for

this purpose. This is a large metallic vat or boiler with air-tight cover and a false bottom, from which rises a trumpet-shaped tube through the middle of the vat, and passing through an air-tight fitting in the cover. The chamber formed by the false bottom is filled with water by means of this tube, the object being to prevent the wine at the lower part from being heated directly by the fire which is below the water-chamber. A thermometer is also inserted air-tight in the lid, with its bulb half-way down the vat. To allow for expansion a tube is similarly fitted into the lid. This is bent siphon-like, and its lower end dipped into a flask containing wine or water, so that air or vapor may escape and bubble through, but none enter. Even in drawing off from the Pasteuring vat into the cask the wine is not allowed to flow through the air, but is conveyed by a pipe which bends down, and dips to the bottom of the barrel.

If heated with exposure to air, the wine acquires a flavor easily recognized as the "goût de cuit," or flavor of cooking. By Pasteur's method, properly carried out, the only changes are those which would be otherwise produced by age.

These changes are somewhat obscure. One effect is probably that which more decidedly occurs in the maturing of whisky and other spirits distilled from grain—viz., the reduction of the proportion of amylic alcohol or fusel-oil, which, although less abundantly produced in the fermentation of grape-juice than in grain or potato spirit, is formed in varying quantities. Caproic alcohol and caprylic alcohol are also produced by the fermentation of grape-juice or the "marc" of grapes, i. e., the mixture of the whole juice and the skins. These are acrid, ill-flavored spirits, more conducive to headache than the ethylic alcohol, which is proper spirit of good wine. Every wine-drinker knows that the amount of headache obtainable from a given quantity of wine, or a given outlay of cash, varies with the sample, and this variation appears to be due to these supplementary alcohols or ethers.

Another change appears to be the formation of ethers having choice flavors and bouquets ; *œnanthic ether*, or the ether of wine, is the most important of these, and it is probably formed by the action of the natural acid salts of the wine upon its alcohol. Johnstone says : "So powerful is the odor of this substance, however, that few wines contain more than one forty-thousandth part of their bulk of it. Yet it is always present, can always be recognized by its smell, and is one of the general characteristics of all grape-wines." This ether is stated to be the basis of *Hungarian wine-oil*, which, according to the same authority, has been sold for flavoring brandy at the rate of sixty-nine dollars per pound. I am surprised that up to the present time it has not been cheaply produced in large quantities. Chemical problems that appear far more difficult have been practically solved.—*Knowledge.*

THE ADVANTAGES OF LIMITED MUSEUMS.

By OSCAR W. COLLET.

BY a museum I do not mean a storehouse of things curious in art or nature—a repository of curiosities, as Worcester defines the word, although in most large towns there are places called museums, and realizing his definition—but a building in which are collected books, and natural or artificial objects that relate to, and are preserved, classified, and conveniently arranged to illustrate, one or more departments of knowledge, and from which objects of mere curiosity are excluded. Assuming that this description is sufficiently accurate and comprehensive for present purposes, it would seem that a museum should be regarded primarily as an instrument to communicate knowledge, and its growth subordinated to such instrumentality that the efficiency of the instrument may be assured. But the instrumentality is passive, not active, and consists in being a repository or source of knowledge for all that choose to avail themselves of it.

Knowledge really valuable, subjectively considered, is thorough; and therefore the instrument of its communication should be adapted and adequate to the purpose to which it is to be applied. Thorough knowledge is not a general acquaintance with everything, but knowing masterfully what one professes to know. If a museum is a storehouse from which knowledge is to be drawn, as knowledge is of many kinds, the repository should be so filled that nothing is wanting. But in most cases this is impossible. There is no reason, theoretically, forbidding an attempt to form a general museum which shall lack nothing necessary to its integrity, but practically failure is certain to result from the want of sufficient means. This difficulty is encountered the world over, and in part has led to the establishment of special museums—natural science, natural history, archæological museums, and the like.

This much premised, we now proceed to the subject of this paper, museums in the Western part of the United States. Respecting these museums we lay down two propositions: 1. They should be limited, not general museums; 2. That each one should select some specialty, and the more distinctly its boundary-lines are drawn the better, even if it be necessary, on the one side or the other, to run them somewhat arbitrarily as to inclusions and exclusions.

The value of every collection intended for scientific purposes and public use—books, natural science objects, ethnographical specimens, it matters not what—does not depend upon quantity or variety, but the completeness of its classes or their subdivisions. A reference library, for instance, that contained every publication of consequence relating to the Mississippi Valley, would be preferable to one more numerously

supplied with books on American history, but wanting many in every department ; or an archæological cabinet able to show all that can be shown of the flint implements of the United States, but little else besides, is of a higher order than one in which there are more and varied specimens, but every class incomplete. What thoroughness is to the intellect, completeness is to a museum ; one, an adequate knowledge of whatever the mind professes specially to occupy itself with, its parts and its relations ; the other, the possession of all the types, sorts, and varieties in fullness, or books, that go to make up one or more classes. If this view is correct, its practical acceptance may be insisted upon ; for, if incorporated into a museum undertaking, not as a theory but what should be realized, it would, by keeping before it a definite and fixed aim, steady and direct effort into proper channels of activity, and check hap-hazard collecting.

It is the part of prudence to aim not at what may be theoretically desirable or best, but at what is practicable. How feeble are the resources, present and prospective, of any Western museum actually existing or likely to be formed ; how totally inadequate to extended work ; how hopeless the prospect of their large increase ! On the other hand, how numerous are the specimens in any one division of the objects of which a museum may be the repository ; how considerable is the expense of bringing them together and of their preservation ! An archæological or a natural history collection, with its building and equipments, moderately furnished with specimens, and including its library, would probably represent a money value of hundreds of thousands of dollars ; were either supplied with all that it properly includes, its real value would be deemed fabulous. What hope is there in these Western countries that an institution which attempted to cover the whole field of archæology, or of natural history, would ever be much more than a very incomplete affair ? And, if special museums are practically fettered by such limitations, how much more general museums ! Therefore, it appears to me that no museum should attempt to be more than a limited museum.

Besides limiting the scope of a museum, whether it includes several of the classes of objects that may find a place in its collections or not, some subdivision of a class should be made a specialty ; for, unless this be done, there is little likelihood of the museum ever possessing a department which will be complete. How immense, for instance, is the number of individual objects necessary to represent, by a single specimen, each of its kind, the animal kingdom, with its six sub-kingdoms, their subdivisions, classes, orders, species, and varieties, already known, from the dawn of animal life down to our own day, besides species and varieties yet to be discovered ! It were useless to compute what the formation of a complete natural history collection involves. Under circumstances far more favorable than any Western museum is likely to find itself in within a century, three generations

would have passed, and such a collection still remain little more than a skeleton; whereas, a subdivision of a class, say flint implements of an archæological collection, to cite another illustration, is something manageable, but to bring even it to completeness is no small undertaking. Of course, there is a difference between one class and another, one subdivision and another, as regards the plentifulness or scarcity of material necessary to its formation, and the facility or difficulty with which it may be obtained; but I doubt whether a complete collection of the flint implements of North America could be made in twenty years, and, were an attempt made to include the flint implements of the world, it would be simply courting failure.

Possibly it may be thought that a museum governed by what is advocated in this paper must progress slowly, and at best long remain a meager and insignificant affair. If progress consists in extending in every direction, the objection is well taken; but, if in an orderly advance toward a fixed point, it is not. But let us see how things would work in practice. A library, of which books relating to the Mississippi Valley are the specialty, completive of its specialty, would find itself in possession of a pretty large collection treating of the history, geography, and legislative affairs of the United States and Canada, and of their aboriginal races, books of statistics and travel, biographies, compilations of documents, histories of the three most prominent countries of Europe, including treatises on their laws and colonial regulations, and numerous publications relating to their religious and ecclesiastical affairs. Again, works on archæology or natural history are an integral part of an archæological or natural history museum, and included in its specialty, no matter what the specialty may be. But to cite the first, as sufficient for our purposes, its books would comprise many thousand titles, beginning with the Bible, and including Homer, Herodotus, and others of the ancients, a multitude of historical books, books of travels, works relating to the aboriginal populations of the world, besides the untold number of publications directly treating archæological topics. In fact, I much doubt whether any one who has not set himself to the task of ascertaining just what an archæological library includes can have even a vague notion of its diversity or extent. As to variety of specimens we shall see presently that it would not be wanting.

But, in insisting that a museum to attain to real excellence should pursue some specialty, it is not intended to limit the choice to any class or subdivision, for circumstances will determine the selection, or to exclude everything else; or, still less, to make the completion of the specialty its ultimate goal, for of all works a museum contains the most vigorous germ of progress, and practically can never be finished; but that the specialty shall be paramount until filled out to the utmost possible. When this term is reached, another subdivision in turn is made the specialty. An instance already cited will serve further to

illustrate what is meant—an archæological museum that makes the flint implements of the United States its specialty. Its aim is to bring together every type, form, variety, and size of objects fashioned by flaking or chipping, of every material used, and in a general way from every locality in the country. But, as it is not possible practically to collect exclusively in one line, other objects will necessarily find their way into the museum at the same time. In exploring, or in acquiring at first hands, a variety of specimens is always obtained. An important source of increase are gifts, and gifts are taken as they come. It is a common thing to acquire collections already formed, and almost invariably they comprise a miscellaneous assortment. The same condition of things will exist, no matter to what objects the museum is devoted or what its specialty may be. Thus, the museum, however rigidly the specialty is kept paramount, in spite of the fact, will also increase in other subdivisions and classes.

What is done by rule and systematically is likely, in the long run, to be well done. But, in order to establish system and prescribe rule, it is requisite first to determine what can and what can not be done, and then what should be done for a reason apparently sufficient, having due regard to the limitations of circumstances and the necessities of the case. This has been my aim, and if I have failed to express myself with all the precision and clearness and fullness that could be desired, there is, nevertheless, I think, a strong, true meaning at bottom in what I have presented, that will approve itself to the thoughtful mind. This much I venture to insist upon, that whether what is advocated be accepted or not, it is, at least, a safe guide to orderly and systematic progress, and to completeness in one or more classes or subdivisions of a museum.

THE ARCHITECTURE OF TOWN-HOUSES.

By ROBERT W. EDIS, F. S. A.

IN choosing as my subject "The Building of Town-Houses," it seemed to me that I might, from the experience gained during the past five-and-twenty years in my professional career as an architect, give some information and suggestions on the various points which should be specially observed and insisted upon in any building wherein sound construction, healthy arrangement, common-sense treatment of the rooms, and practical knowledge in their general fitting up, are all-important, where health, cleanliness, and comfort, and economy of service and labor, are considered necessary.

The speculative builders have too long had their way without control of any kind, save that which is provided for under the Metropolitan Building and other local acts, which simply permit of the dis-

trict surveyors insisting upon certain thicknesses of walls, but give them no power to reject inferior materials, or to prevent scamping and unsound work, and the disregard of all known sanitary laws, and of the commonest precautions to insure health and comfort.

It is surely time that every house erected in the great centers of habitation should have some systematic supervision, so that ordinary precautions shall be insisted upon to secure proper sanitation, to prevent the use of grossly inferior materials, and to prevent these plague-spots being formed in our midst; for it must be borne in mind that every house built under the system I have condemned not only tends to the individual discomfort of the special occupier, but adds materially to the unhealthiness of a neighborhood.

In the building of new and the rebuilding of old houses, it is essential that proper regard shall be had to the rapid growth of sanitary science, and not only to comply with, but "anticipate as far as possible, its many requirements, and especially those of them which will, I believe, in a few years be considered by the population at large as absolutely necessary for habitable dwellings, not only as regards the actual sanitary fittings and appliances of the houses themselves, but also as regards their actual construction from the foundation upward, and also more especially as regards the light and air spaces with which they are surrounded."

If our towns are to be reconstructed and added to on healthy and proper principles, each house must be properly constructed, and certain fixed rules insisted upon, as regards proper general health arrangement and sanitation; for "the same rule," to quote Dr. Richardson, "applies to accumulation of health as to the accumulation of wealth." "Take care of the pennies," says the financier, "the pounds will take care of themselves." "Take care of the houses," says the sanitarian, "the towns will take care of themselves." It follows, therefore, that so far as common-sense laws can be applied to the rebuilding of the houses of closely packed communities, they should be on some general and uniform system, so far as laws of health are concerned, which all must follow. But this only applies to sanitation; so far as general arrangement is concerned, the wants of the individual must necessarily be consulted; and, so far as the artistic improvement of our towns is concerned, I am strongly of opinion that the greater the variety of designs, the greater will be the artistic character and general picturesqueness of our streets.

To sacrifice internal comfort, light, and ventilation to some special order of fenestration, Greek, Roman, or Italian, or to the cramped and narrow lines of a mediæval fortress or building of by-gone ages, seems to me to convey nothing but poverty of thought, or narrow-minded conventionalism, as opposed to all true principles of architecture as it is to the wants and requirements of the people of the nineteenth century.

Comfort and convenience of arrangement, ample light and ventilation everywhere; protection from damp and miasma, impure and unhealthy smells; warmth, freedom from draught; pure air, pure water, general cleanliness, and attention to all laws of sanitation, are first of all to be considered in every house. The architect or artist can so fashion the external clothing of a good framework as to make it agreeable in its outline and general constructive decoration; but the elevation should be subservient to the plan and constructional requirements necessary to provide all these desiderata, and should not be made the paramount feature in the design of a new house, or in the rebuilding of an old one.

I have lately been reading a powerfully written article by Dr. Richardson, in which he sets forth, in vigorous but not exaggerated language, the various communicable diseases which are "promoted or introduced by the errors of construction in the dwellings of our communities"; and I have been much struck by the number of preventable ills which he associates with bad ventilation, damp, bad drainage, impure water-supplies, want of light and through draught, uncleanliness and foulness, or stuffiness of modern dwellings; and I hope you will permit me briefly to refer to and quote some of his remarks.

To begin with, typhus, typhoid, relapsing and scarlet fevers, are mainly due to foul air, impure smell, or water, or closely packed and unventilated rooms, while the poisons thrown off by these diseases are retained in the walls and flooring, if badly constructed; while impure air arising from dust and dirt accumulations, and bad sanitation, tend to other illnesses in a minor degree, such as dyspepsia, nervousness, and depression, "during the presence of which conditions" (to quote Dr. Richardson) "a person is neither well nor ill." Another of our worst English diseases, "pulmonary consumption, or consumption of the lungs, has been largely promoted by the presence of unchanged and impure air in the dwelling-house," while "neuralgic and miasmatic diseases" are brought about by the same causes, assisted by atmospheric moisture or damp, so often to be found in houses built either upon clay or in moist situations, where the ordinary precautions of covering the whole surface area with concrete or some other damp preventive has not been carried out.

Dampness is more or less directly the cause of all the malarious diseases—ague, neuralgia, and rheumatism—and here the speculative builder comes in, with venom certain and incurable, with soft, spongy bricks which absorb a large amount of water, with mortar composed of road drift or scrapings, foul and unhealthy; with damp and unseasoned timber, ingredients in the plague-spots which warmth of fires bring out in vapor, and wherein moisture seems ever present, dimming the mirrors or condensing on painted walls, or absorbed in paper or distemper, which, on every damp day, becomes a visible barometer, marking plainly the change of temperature.

In badly-constructed and ill-arranged houses, how often do we hear the inhabitants complain of what is technically called "draught," which means sudden and irregular change of temperature! Unpleasant as it is in itself, it is most insidious and dangerous in its results, bringing about colds, chills, and general "disturbance in the circulation of the organs of the body."

It is unnecessary to dwell further upon the numerous ills which we have it in our power to lessen, or altogether get rid of, by attention to the general construction of the houses we live in. I can only insist generally, with Dr. Richardson, that "the intention and object of domestic sanitation is so to construct houses for human beings, or, if the houses be constructed, so to improve them, that the various diseases and ailments incident to bad construction may be removed to the fullest possible extent. The diseases need not be looked upon as necessities of existence, but may be recognized as results of ignorance, or as accidents which, though they may not spring from sheer and wanton ignorance, are removable by accurate foreseeing and all-providing knowledge."

In towns, where, for the most part, all houses are built in groups, either in streets, terraces, or squares, and rarely detached, the general aspect is naturally fixed by the location of the building, and the laying out of the street or terrace of which the particular house already forms or is to form a part; and, therefore, it is of the utmost importance as far as possible to secure as much light and sun as can be obtained by the slightly varied aspect which is given by semi-octagonal or circular-projecting windows with side-lights, more especially where the plotting of the site lies more or less due north and south.

Nothing can be more miserable and unartistic, nothing more insulting to good taste, than the dreary monotony and vulgarity of most London streets, old and new. How much more artistic and picturesque could our streets be made if broken up with bays and gables, cutting up the sky-line, like the streets in many of the old towns in Germany and Belgium; and how much more cheerful and healthy would be the rooms wherein these bays are thrown out, and through which sun, air, and light can be obtained in more ample quantity, than by means of the two or three parallelogram-shaped openings which generally form the windows in most London fronts! Anyway, there is an old adage, which is more or less true, that, "where the sun does not enter, sickness in some sort or way is sure to obtain." We do not get too much sun in smoke-covered towns; and surely every possible allowance, consistent of course with what is due to the comfort and enjoyment of our neighbors, should be made for flat-sided projections, by which more sun and light can be given to our homes.

Fancy being on the south side of a street, where the windows face due north, and into which, for nearly the whole of the year, the sun can never shine, save very occasionally in thin, slantwise streaks. Were

it not for the generally disagreeable views that are obtainable from the backs of town-houses, I should be often inclined to advise that all the best rooms in such a case should be placed at the back, with projecting bays, and so to obtain, as far as is practicable, some glimpse and use of the sun during all hours of the day.

Why, too, can not the backs of our houses be made more decent, if only by means of glazed bricks varied occasionally with bands of color? When we see the backs of some of the grand, stucco-covered palaces of our western suburbs, we are apt to think of the old rhyme which, written on some piece of modern church or chapel architecture, says that—

> "They built the front, upon my word,
> As fine as any abbey;
> And, thinking they might cheat the Lord,
> They made the back part shabby."

Of course, I know glazed bricks are more expensive than the common stocks, but the extra expense would be amply repaid by the extra light and better air, for the glaze naturally makes the brick not absorbent, and every shower of rain would wash the walls, so faced, clean.

Why should we not have every new house in such places as Berkeley or Grosvenor Squares built with projecting oriels and bays, and high-pitched gables? The gables would add materially to the light and comfort—not to say anything of the artistic character—of the rooms, while the latter would surely be preferable to the generally miserable so-called dormers, which are, as a rule, set back behind the balconies or parapets, in the attics of most town-houses; these, I am told often, are quite good enough for servants, a selfish, cruel, if not a suicidal opinion; for, if we are to have servants in health, and fitted to carry out their daily occupations, with comfort to themselves and justice to their employers, their rooms should be just as light, airy, and cheerful as any others in the house. Let the sun call them in the morning if you can, and give a greeting in a light, cheery manner to the commencement of their daily labor. In addition to the manifest improvement to the elevation and rooms of the house, all these irregularities tend to promote movement in the air, to give light and shade, and thus to help toward health in the building, and pleasure in our walks abroad.

In speaking upon the next part of my subject, that of design, I desire to recognize and appreciate, in the largest possible sense, the varieties of taste which must necessarily prevail in an age where, as a rule, precedent and fashion are all-predominant; but I do insist that the external design, properly considered, that is, the general elevation of the street front, should and must be subservient to the internal requirements; and that the light, air, ventilation, and common-sense requirements of the house must in no way be sacrificed to the external

design, for no beauty of mere architectural effect will compensate for discomfort and bad internal arrangement.

A good plan will make a good elevation; but an elevation in which specific rules which might be fitting for a Greek temple or a mediæval fortress are insisted on, is in no way suitable to an ordinary house, in which the first essentials are lofty and well-arranged windows, and proper light and air space.

Gothic tracery and pointed openings are not suited to ordinary sash-windows, and it surely is inconsistent with modern street design to attempt anything in which one or other of the so-called five orders of classic architecture has to be worked into a house in which the frontage is perhaps eighteen or twenty feet at most. When it was attempted in the beginning of this century, in the terraces of Regent's Park, generally two or more houses were embraced in the design, a manifest inconvenience and absurdity when one owner wants to paint his front red and the other yellow.

The fashion of the day is running into modern Dutch, or so-called Queen Anne, and inasmuch as this style admits of ample fenestration, and does not limit the size of light-openings, and relies for its piquancy and character on honest red brick instead of sham plaster and vulgar imitation, we may be thankful for small mercies, and be content with a revival of a sixteenth and seventeenth century Renaissance school of architecture, which gives us at least color and picturesqueness in our London streets.

I go so far as to say that the man who builds a red-brick house in a town, where want of color tends to make everything glaring or, where smoke-covered, gloomy, is a benefactor to his species; and I go still further in saying that to a great extent the materials used should, in a manner, be those which are peculiar to the country and locality. Stone of various kinds is indigenous to certain localities, and naturally suggests itself to the particular neighborhoods.

We have plenty of good brick clay; we can obtain readily first-class red bricks and terra-cotta, and both these materials are more lasting and more suitable to London smoke and the deleterious action of London atmosphere than almost any stone which exists.

Glazed and colored brick, and faïence, and terra-cotta, admit of almost any variety of design; they give picturesqueness, warmth, and color where they are wanted.

I should like to see London streets made picturesque and beautiful in color, with terra-cotta and glazed faïence, which every shower of rain would cleanse and improve, and should like to see every stucco-fronted building decaying and unlet. As a rule, this sort of work is not only imitation of stone, bad in taste, bad in construction, and unfit to last any time, but glosses over inferior building, and covers a multitude of sins which it would be well for the occupiers, from a mere common-sense and sanitary point of view, to lay bare.

We do not want pseudo-Italian palaces, or bad copies of French street architecture, with forced arrangement of fenestration and cutting up of wall-space, utterly at variance with home requirements; nor do we want so-called mediæval structures, in which light, ventilation, and air are sacrificed to narrow Gothic or pointed-headed windows and doorways.

So far as I can judge, it seems to me that the so-called Elizabethan, or later Renaissance, of this country is infinitely more charming and more suitable to every-day wants and requirements than any other style, Greek, Roman, or Gothic; anyway, we want to express in our external work a sense of comfort and utility, and to provide ample light and air-space for the rooms, of which the front wall is only the external casing; and any style which combines these desiderata will commend itself to common-sense people.

Good architectural effect may be perfectly well obtainable with a good common-sense plan, and there is no possible excuse for a design, whether classic, Gothic, or Queen Anne, which does not first of all recognize the internal necessities and conveniences, and which is not subordinate to a great extent to every-day internal requirements of a well-arranged and comfortable house. While I advocate first of all that the elevation or design should be made subservient to the plan, I do not see the necessity of following the types of various schools of French, Italian, or thirteenth, fourteenth, or fifteenth century Gothic buildings; and, when I see the pretentiousness of imitation of either of these schools, I am bound to confess that it suggests nothing but an ignorant conceit, which would not for a moment have been carried out by the great architects, whose works we admire, had they had all the modern improvements which increased knowledge and higher skill in invention have brought about.

In our monumental buildings, and even in our ordinary street fronts, architecture should be much more intimately allied with the sister arts of sculpture and painting. Even a porch in which the ornament is modeled with care by an artist, or the corbel of a projecting bay, will redeem an otherwise bad design from commonplaceness; a proper regard for proportion and arrangement of outline in the most simple building shows the work of a true artist, much more than the overlaying of his work with useless ornament or carving, or the overcrowding of parts with feeble enrichment stuck on balustrading and pediments. In house-design, it seems to me that, first of all, the de sign should convey some expression of the comfort and general planning of the building, and that its fenestration should show, above all, proper regard to the lighting and ventilation of the rooms, and generally bear the characteristics of the material with which it is carried out.

If importance is wanted in an elevation, let it be got by good sculpture in such portions of the building as are nearest the eye-line; a porch properly treated with good modeled decoration, either in figure

or relief ornament, can be made as imposing as you like, while balcony-fronts can be of good wrought-iron, like some of those in the old picturesque towns of Spain and Germany, instead of lumpy and heavy with balustrading, which not only shuts out light from the rooms, but suggests an element of danger by their utterly false and generally insufficient construction; but I confess to a feeling of astonishment when I see friezes and cornices of buildings in narrow streets, some forty or fifty feet from the street-level, covered with elaborate carving and enrichment which it is impossible even to look at without craning the neck, and which can only be appreciated by the servants who inhabit the attics over the way. There is no possible reason why street frontages should not be made picturesque and beautiful instead of tame and ugly, and the commonest of fronts can often be redeemed by some good bit of detail and decoration in the shape of red brick, terra-cotta, or glazed faïence. Picturesque fronts, with projecting oriels or bays and gabled roofs, need cost no more than some of these wretched travesties of Italian or French architecture, with so-called Mansard-roofs and cramped dormer lights, and would give grace and charm, and color, where now commonplaceness, vulgarity, and bad taste reign supreme.

Too often the first principles of proportion are lost sight of, owing to the want of proper culture of the eye, and details which might be well suited to a Genoese or Roman palace are stuck on to a narrow street frontage.

There is no need why London street architecture should not embody every modern improvement, and be carried out in a common-sense and picturesque style, suitable for every-day wants, and in conformity with all the various scientific principles of sanitation which the nineteenth century has produced, "instead of resuscitating old forms and old features, which our forefathers would have gladly changed" had they had the knowledge or benefit of modern improvements. I have no desire to see any one uniform style of building, but, whatever style is taken up by the individual owner, it is first of all essential that it should be made to adapt itself to the internal requirements, and that there be ample light, and common-sense treatment of the window-spaces, so that they be arranged in the rooms in proper places, and not thrust into corners, or raised so high from the floors as to be prison-like, to suit the external design; and whether Greek, Italian, Queen Anne, or any date or period of so-called Gothic art, it must be governed by present wants, and possess every sanitary and modern invention which may make the individual house more comfortable, more healthy, and more convenient for the purposes for which it is required.

Renaissance, whether German, Italian, or French, freely or simply treated, and all the later phases of the Jacobean and English Elizabethan periods, are capable of being successfully adapted to present home-life and modern requirements.

So far as my experience goes, the public generally are unaware of the real advantages and merits of terra-cotta for facing street fronts. When properly burned, it is absolutely impervious to smoke, and is unaffected by acid fumes of any description ; it is about half the weight of the lightest building-stones, and its resistance, when burned in solid blocks in compression, is nearly one third greater than that of Portland stone ; it is not absorbent—a great desideratum when damp has to be considered—it is easily molded into any shape, for strings, cornices, or window-sills and architraves, and can be easily modeled for figure or other enrichment. It can be got in good warm yellow or red color, and, when glazed, can be produced in almost any tones of soft browns, greens, reds, or yellows ; and its strength, durability, and imperviousness to all the destructive influences of town atmospheres, to my mind, recommend it as the building material most adapted for facing street frontages.

Let me say a few words about iron railings. To what disastrous order of things we owe the prison-like bars and straight lines of the ordinary front railings in our streets, I am at a loss to understand ; but surely nothing can be more hideous or more unartistic. Why cannot we redeem the general want of taste in London streets by something like good design in balcony-fronts or area-railings? They may be made just as secure, and just as useful, if made ornamental in form, like the beautiful iron-work of the old towns in Spain, Italy, and Germany, which can be seen in the humblest street front as well as in the princely palaces ; or like the English work of the last century, some few specimens of which remain.

It is in these small matters that the taste of a people is shown, and it is by these minor features of design in the necessities of street architecture that picturesqueness and grace are to be obtained.

Let me close this lecture by a quotation from one delivered over a quarter of a century ago, by a writer who was then one of the greatest of living word-painters :

"If you build well and artistically, you will talk to all who pass by, and all those little sympathies, those freaks of fancy, those jests in stone, those workings out of problems in caprice, will occupy mind after mind of utterly countless multitudes, long after you are gone. You have not, like authors, to plead for a hearing, or to fear oblivion. Do but build large enough and boldly enough, and all the world will hear you ; they can not choose but look."—*Abridged from the Journal of the Society of Arts.*

MOUNTAIN OBSERVATORIES.

ON October 1, 1876, one of the millionaires of the New World died at San Francisco. Although owning a no more euphonious name than James Lick, he had contrived to secure a future for it. He had founded and endowed the first great astronomical establishment planted on the heights, between the stars and the sea. How he came by his love of science we have no means of knowing. Born obscurely at Fredericksburg, in Pennsylvania, August 25, 1796, he amassed some thirty thousand dollars by commerce in South America, and in 1847 transferred them and himself to a village which had just exchanged its name of Yerba Buena for that of San Francisco, situate on a long, sandy strip of land between the Pacific and a great bay. In the hillocks and gullies of that wind-blown barrier he invested his dollars, and never did virgin-soil yield a richer harvest. The gold-fever broke out in the spring of 1848. The unremembered cluster of wooden houses, with no trouble or tumult of population in their midst, nestling round a tranquil creek under a climate which, but for a touch of sea-fog, might rival that of the Garden of the Hesperides, became all at once a center of attraction to the outcast and adventurous from every part of the world. Wealth poured in; trade sprang up; a population of six hundred increased to a quarter of a million; hotels, villas, public edifices, places of business spread, mile after mile, along the bay; building-ground rose to a fabulous price, and James Lick found himself one of the richest men in the United States.

Thus he got his money; we have now to see how he spent it. Already the munificent benefactor of the learned institutions of California, he in 1874 formally set aside a sum of two million dollars for various public purposes, philanthropic, patriotic, and scientific. Of these two millions, seven hundred thousand were appropriated to the erection of a telescope "superior to and more powerful than any ever yet made." But this, he felt instinctively, was not enough. Even in astronomy, although most likely unable to distinguish the pole-star from the dog-star, this "pioneer citizen" could read the signs of the times. It was no longer instruments that were wanted; it was the opportunity of employing them. Telescopes of vast power and exquisite perfection had ceased to be a rarity; but their use seemed all but hopelessly impeded by the very conditions of existence on the surface of the earth.

The air we breathe is in truth the worst enemy of the astronomer's observations. It is their enemy in two ways. Part of the light which brings its wonderful, evanescent messages across inconceivable depths of space, it stops; and, what it does not stop, it shatters. And this even when it is most transparent and seemingly still; when mist-veils are withdrawn, and no clouds curtain the sky. Moreover, the evil

grows with the power of the instrument. Atmospheric troubles are magnified neither more nor less than the objects viewed across them. Thus, Lord Rosse's giant reflector possesses—*nominally*—a magnifying power of 6,000; that is to say, it can reduce the *apparent* distances of the heavenly bodies to $\frac{1}{6000}$ their *actual* amount. The moon, for example, which is in reality separated from the earth's surface by an interval of about two hundred and thirty-four thousand miles, is shown as if removed only thirty-nine miles. Unfortunately, however, in theory only. Professor Newcomb compares the sight obtained under such circumstances to a glimpse through several yards of running water, and doubts whether our satellite has ever been seen to such advantage as it would be if brought—substantially, not merely optically—within five hundred miles of the unassisted eye.*

Must, then, all the glowing triumphs of the optician's skill be counteracted by this plague of moving air? Can nothing be done to get rid of, or render it less obnoxious? Or is this an ultimate barrier, set up by Nature herself, to stop the way of astronomical progress? Much depends upon the answer—more than can, in a few words, be easily made to appear; but there is fortunately reason to believe that it will, on the whole, prove favorable to human ingenuity, and the rapid advance of human knowledge on the noblest subject with which it is or ever can be conversant.

The one obvious way of meeting atmospheric impediments is to leave part of the impeding atmosphere behind; and this the rugged shell of our planet offers ample means of doing. Whether the advantages derived from increased altitudes will outweigh the practical difficulties attending such a system of observation when conducted on a great scale, has yet to be decided. The experiment, however, is now about to be tried simultaneously in several parts of the globe.

By far the most considerable of these experiments is that of the "Lick Observatory." Its founder was from the first determined that the powers of his great telescope should, as little as possible, be fettered by the hostility of the elements. The choice of its local habitation was, accordingly, a matter of grave deliberation to him for some time previous to his death. Although close upon his eightieth year, he himself spent a night upon the summit of Mount St. Helena, with a view to testing its astronomical capabilities, and a site already secured in the Sierra Nevada was abandoned on the ground of climatic disqualifications. Finally, one of the culminating peaks of the Coast Range, elevated 4,440 feet above the sea, was fixed upon. Situated about fifty miles southeast of San Francisco, Mount Hamilton lies far enough inland to escape the sea-fog, which only on the rarest occasions drifts upward to its triple crest. All through the summer the sky above it is limpid and cloudless; and, though winter storms are frequent, their raging is not without highly available lucid intervals. As

* "Popular Astronomy," p. 145.

to the essential point—the quality of telescopic vision—the testimony of Mr. S. W. Burnham is in the highest degree encouraging. This well-known observer spent two months on the mountain in the autumn of 1879, and concluded, as the result of his experience during that time—with the full concurrence of Professor Newcomb—that "it is the finest observing location in the United States." Out of sixty nights he found forty-two as nearly perfect as nights can well be, seven of medium quality, and only eleven cloudy or foggy;* his stay, nevertheless, embraced the first half of October, by no means considered to belong to the choice part of the season. Nor was his trip barren of discovery. A list of forty-two new double stars gave an earnest of what may be expected from systematic work in such an unrivaled situation. Most of these are objects which never rise high enough in the sky to be examined with any profit through the grosser atmosphere of the plains east of the Rocky Mountains; some are well-known stars, not before seen clearly enough for the discernment of their composite character; yet Mr. Burnham used the lesser of two telescopes—a 6-inch and an 18-inch achromatic—with which he had been accustomed to observe at Chicago.

The largest refracting telescope as yet actually completed has a light-gathering surface twenty-seven inches in diameter. This is the great Vienna equatorial, admirably turned out by Mr. Grubb, of Dublin, in 1880, but still awaiting the commencement of its exploring career. It will, however, soon be surpassed by the Pulkowa telescope, ordered more than four years ago on behalf of the Russian Government from Alvan Clark & Sons, of Cambridgeport, Massachusetts. Still further will it be surpassed by the coming "Lick Refractor." It is safe to predict that the optical championship of the world is, at least for the next few years, secured to this gigantic instrument, the completion of which may be looked for in the immediate future. It will have a clear aperture of *three feet*. A disk of flint-glass for the object-lens, 38·18 inches across, and one hundred and seventy kilogrammes in weight, was cast at the establishment of M. Feil, in Paris, early in 1882. Four days were spent and eight tons of coal consumed in the casting of this vast mass of flawless crystal; it took a calendar month to cool, and cost two thousand pounds sterling.† It may be regarded as the highest triumph so far achieved in the art of optical glass-making.

A refracting telescope three feet in aperture collects rather more light than a speculum of four feet.‡ In this quality, then, the Lick

* "The Observatory," No. 43, p. 613.

† "Nature," vol. xxv, p. 537.

‡ Silvered glass is considerably more reflective than speculum-metal, and Mr. Common's 36-inch mirror can be but slightly inferior in luminous capacity to the Lick objective. It is, however, devoted almost exclusively to celestial photography, in which it has done splendid service. The Paris 4-foot mirror bent under its own weight when placed in the tube in 1875, and has not since been remounted.

instrument will have—besides the Rosse leviathan, which, for many reasons, may be considered to be out of the running—but one rival. And over this rival—the 48-inch reflector of the Melbourne Observatory—it will have all the advantages of agility and robustness (so to speak) which its system of construction affords; while the exquisite definition for which Alvan Clark is famous will, presumably, not be absent.

Already preparations are being made for its reception at Mount Hamilton. The scabrous summit of "Observatory Peak" has been smoothed down to a suitable equality of surface by the removal of 40,000 tons of hard trap-rock. Preliminary operations for the erection of a dome, seventy-five feet in diameter, to serve as its shelter, are in progress. The water-supply has been provided for by the excavation of great cisterns. Buildings are being rapidly pushed forward from designs prepared by Professors Holden and Newcomb. Most of the subsidiary instruments have for some time been in their places, constituting in themselves an equipment of no mean order. With their aid Professor Holden and Mr. Burnham observed the transit of Mercury of November 7, 1881, and Professor Todd obtained, December 6, 1882, a series of 147 photographs (of which seventy-one were of the highest excellence) recording the progress of Venus across the face of the sun.

We are informed that a great hotel will eventually add the inducement of material well-being to those of astronomical interest and enchanting scenery. No more delightful summer resort can well be imagined. The road to the summit, of which the construction formed the subject of a species of treaty between Mr. Lick and the county of Santa Clara in 1875, traverses from San José a distance, as a bird flies, of less than thirteen miles, but doubled by the windings necessary in order to secure moderate gradients. So successfully has this been accomplished, that a horse drawing a light wagon can reach the observatory buildings without breaking his trot.* As the ascending track draws its coils closer and closer round the mountain, the view becomes at every turn more varied and more extensive. On one side the tumultuous Coast Ranges, stooping gradually to the shore, magnificently clad with forests of pine and red cedar; the island-studded bay of San Francisco, and farther south, a shining glimpse of the Pacific; on the other, the thronging pinnacles of the Sierras—granite needles, lava-topped bastions—fire-rent, water-worn; right underneath, the rich valleys of Santa Clara and San Joaquin, and 175 miles away to the north (when the sapphire of the sky is purest), the snowy cone of Mount Shasta.

Thus, there seems some reason to apprehend that Mount Hamilton, with its monster telescope, may become one of the show-places of the New World. *Absit omen!* Such a desecration would effectually mar one of the fairest prospects opened in our time before astronomy. The

* E. Holden, "The Lick Observatory," "Nature," vol. xxv, p. 298.

true votaries of Urania will then be driven to seek sanctuary in some less accessible and less inviting spot. Indeed, the present needs of science are by no means met by an elevation above the sea of four thousand and odd feet, even under the most translucent sky in the world. Already observing stations are recommended at four times that altitude, and the ambition of the new species of climbing astronomer seems unlikely to be satisfied until he can no longer find wherewith to fill his lungs (for even an astronomer must breathe), or whereon to plant his instruments.

This ambition is no casual caprice. It has grown out of the growing exigencies of celestial observation.

From the time that Lord Rosse's great reflector was pointed to the sky in February, 1845, it began to be distinctly felt that instrumental power had outrun its opportunities. To the sounding of further depths of space it came to be understood that Atlantic mists and tremulous light formed an obstacle far more serious than any mere optical or mechanical difficulties. The late Mr. Lassell was the first to act on this new idea. Toward the close of 1852 he transported his beautiful 24-inch Newtonian to Malta, and, in 1859–'60, constructed, for service there, one of four times its light-capacity. Yet the chief results of several years' continuous observation under rarely favorable conditions were, in his own words, "rather negative than positive."* He dispelled the "ghosts" of four Uranian moons which had, by glimpses, haunted the usually unerring vision of the elder Herschel, and showed that our acquaintance with the satellite families of Saturn, Uranus, and Neptune must, for the present at any rate, be regarded as complete; but the discoveries by which his name is chiefly remembered were made in the murky air of Lancashire.

The celebrated expedition to the Peak of Teneriffe, carried out in the summer of 1856 by the present Astronomer Royal for Scotland, was an experiment made with the express object of ascertaining "how much astronomical observation can be benefited by eliminating the lower third or fourth part of the atmosphere." † So striking were the advantages of which it seemed to hold out the promise, that we count with surprise the many years suffered to elapse before any adequate attempt was made to realize them.‡ Professor Piazzi Smyth made his principal station at Guajara, 8,903 feet above the sea, close to the rim of the ancient crater from which the actual peak rises to a further height of more than 3,000 feet. There he found that his equatorial (five feet in focal length) showed stars fainter by *four magnitudes* than at Edinburgh. On the Calton Hill the companion of Alpha Lyræ (eleventh magnitude) could never, under any circumstances, be

* "Monthly Notices," Royal Astronomical Society, vol. xiv, p. 133, 1854.

† "Philosophical Transactions," vol. cxlviii, p. 465.

‡ Captain Jacob unfortunately died August 16, 1862, when about to assume the direction of a hill observatory at Poonah.

made out. At Guajara it was an easy object twenty-five degrees from the zenith; and stars of the fourteenth magnitude were discernible. Now, according to the usual estimate, a step downward from one magnitude to another means a decrease of luster in the proportion of two to five. A star of the fourteenth order of brightness sends us accordingly only one thirty-ninth as much light as an average one of the tenth order. So that, in Professor Smyth's judgment, the grasp of his instrument was virtually *multiplied thirty-nine times* by getting rid of the lowest quarter of the atmosphere.* In other words (since light falls off in intensity as the square of the distance of its source increases), the range of vision was more than sextupled, further depths of space being penetrated to an extent probably to be measured by thousands of billions of miles!

This vast augmentation of telescopic compass was due as much to the increased tranquillity as to the increased transparency of the air. The stars hardly seemed to twinkle at all. Their rays, instead of being broken and scattered by continual changes of refractive power in the atmospheric layers through which their path lay, traveled with relatively little disturbance, and thus produced a far more vivid and concentrated impression upon the eye. Their images in the telescope, with a magnifying power of one hundred and fifty, showed no longer the "amorphous figures" seen at Edinburgh, but such minute, sharply-defined disks as gladden the eyes of an astronomer, and seem, in Professor Smyth's phrase, to "provoke" (as the "cocked-hat" appearance surely baffles) "the application of a wire-micrometer" for purposes of measurement.†

The luster of the milky way and zodiacal light at this elevated station was indescribable, and Jupiter shone with extraordinary splendor. Nevertheless, not even the most fugitive glimpse of any of his satellites was to be had without optical aid.‡ This was possibly attributable to the prevalent "dust-haze," which must have caused a diffusion of light in the neighborhood of the planet more than sufficient to blot from sight such faint objects. The same cause completely neutralized the darkening of the sky usually attendant upon ascents into the more ethereal regions, and surrounded the sun with an intense glare of reflected light. For reasons presently to be explained, this circumstance alone would render the Peak of Teneriffe wholly unfit to be the site of a modern observatory.

* The height of the mercury at Guajara is 21·7 to 22 inches.

† "Philosophical Transactions," vol. cxlviii, p. 477.

‡ We are told that three American observers in the Rocky Mountains, belonging to the Eclipse Expedition of 1878, easily saw Jupiter's satellites night after night with the naked eye. That their discernment is possible even under comparatively disadvantageous circumstances is rendered certain by the well-authenticated instance (related by Humboldt, "Cosmos," vol. iii, p. 66, Otte's translation) of a tailor named Schön, who died at Breslau in 1837. This man habitually perceived the first and third, but never could see the second or fourth, Jovian moons.

Within the last thirty years a remarkable change, long in preparation,* has conspicuously affected the methods and aims of astronomy; or, rather, beside the old astronomy—the astronomy of Laplace, of Bessel, of Airy, Adams, and Leverrier—has grown up a younger science, vigorous, inspiring, seductive, revolutionary, walking with hurried or halting footsteps along paths far removed from the staid courses of its predecessor. This new science concerns itself with the *nature* of the heavenly bodies; the elder regarded exclusively their *movements*. The aim of the one is *description*, of the other *prediction*. The younger science inquires what sun, moon, stars, and nebulæ are made of, what stores of heat they possess, what changes are in progress within their substance, what vicissitudes they have undergone or are likely to undergo. The elder has attained its object when the theory of celestial motions shows no discrepancy with fact—when the calculus can be brought to agree perfectly with the telescope—when the coursers of the heavens come strictly up to time, and their observed places square to a hair's breadth with their predicted places.

It is evident that very different modes of investigation must be employed to further such different objects; in fact, the invention of novel modes of investigation has had a prime share in bringing about the change in question. Geometrical astronomy, or the astronomy of position, seeks above all to measure with exactness, and is thus more fundamentally interested in the accurate division and accurate centering of circles than in the development of optical appliances. Descriptive astronomy, on the other hand, seeks as the first condition of its existence to *see* clearly and fully. It has no "method of least squares" for making the best of bad observations—no process for eliminating errors by their multiplication in opposite directions; it is wholly dependent for its data on the quantity and quality of the rays focused by its telescopes, sifted by its spectroscopes, or printed in its photographic cameras. Therefore, the loss and disturbance suffered by those rays in traversing our atmosphere constitute an obstacle to progress far more serious now than when the exact determination of places was the primary and all-important task of an astronomical observer. This obstacle, which no ingenuity can avail to remove, may be reduced to less formidable dimensions. It may be diminished or partially evaded by anticipating the most detrimental part of the atmospheric transit—by carrying our instruments upward into a finer air—by meeting the light upon the mountains.

The study of the sun's composition, and of the nature of the stupendous processes by which his ample outflow of light and heat is kept up and diffused through surrounding space, has in our time separated,

* Sir W. Herschel's great undertakings, Bessel remarks ("Populäre Vorlesungen," p. 15), "were directed rather toward a physical description of the heavens than to astronomy proper."

it might be said, into a science apart. Its pursuit is, at any rate, far too arduous to be conducted with less than a man's whole energies; while the questions which it has addressed itself to answer are the fundamental problems of the new physical astronomy. There is, however, but one opinion as to the expediency of carrying on solar investigations at greater altitudes than have hitherto been more than temporarily available.

The spectroscope and the camera are now the chief engines of solar research. Mere telescopic observation, though always an indispensable adjunct, may be considered to have sunk into a secondary position. But the spectroscope and the camera, still more than the telescope, lie at the mercy of atmospheric vapors and undulations. The late Professor Henry Draper, of New York, an adept in the art of celestial photography, stated in 1877 that two years, during which he had photographed the moon at his observatory on the Hudson on every moonlit night, yielded *only three* when the air was still enough to give good results, nor even then without some unsteadiness; and Bond, of Cambridge (U. S.), informed him that he had watched in vain, through no less than seventeen years, for a faultless condition of our troublesome environing medium.* Tranquillity is the first requisite for a successful astronomical photograph. The hour generally chosen for employing the sun as his own limner is, for this reason, in the early morning, before the newly emerged beams have had time to set the air in commotion, and so blur the marvelous details of his surface-structure. By this means a better definition is secured, but at the expense of transparency. Both are, at the sea-level, hardly ever combined. A certain amount of haziness is the price usually paid for exceptional stillness, so that it not unfrequently happens that astronomers see best in a fog, as on the night of November 15, 1850, when the elder Bond discovered the "dusky ring" of Saturn, although at the time no star below the fourth magnitude could be made out with the naked eye. Now, on well-chosen mountain-stations, a union of these unhappily divorced conditions is at certain times to be met with, opportunities being thus afforded with tolerable certainty and no great rarity, which an astronomer on the plains might think himself fortunate in securing once or twice in a lifetime.

For spectroscopic observations at the edge of the sun, on the contrary, the *sine qua non* is translucency. During the great "Indian eclipse" of August 18, 1868, the variously-colored lines were, by the aid of prismatic analysis, first descried, which reveal the chemical constitution of the flame-like "prominences," forming an ever-varying, but rarely absent, feature of the solar surroundings. Immediately afterward, M. Janssen, at Guntoor, and Mr. Norman Lockyer, in England, independently realized a method of bringing them into view without the co-operation of the eclipsing moon.

* "American Journal of Science," vol. xiii, p. 89.

This was done by *fanning out* with a powerfully dispersive spectroscope the diffused radiance near the sun, until it became sufficiently attenuated to permit the delicate flame-lines to appear upon its rainbow-tinted background. This mischievous radiance—which it is the chief merit of a solar eclipse to abolish during some brief moments—is due to the action of the atmosphere, and chiefly of the watery vapors contained in it. Were our earth stripped of its "cloud of all-sustaining air," and presented, like its satellite, bare to space, the sky would appear perfectly black up to the very rim of the sun's disk—a state of things of all others (vital necessities apart) the most desirable to spectroscopists. The best approach to its attainment is made by mounting a few thousand feet above the earth's surface. In the drier and purer air of the mountains, "glare" notably diminishes, and the tell-tale prominence-lines are thus more easily disengaged from the effacing luster in which they hang, as it were, suspended.

The Peak of Teneriffe, as we have seen, offers a marked exception to this rule, the impalpable dust diffused through the air giving, even at its summit, precisely the same kind of detailed reflection as aqueous vapors at lower levels. It is accordingly destitute of one of the chief qualifications for serving as a point of vantage to observers of the new type.

The changes in the spectra of chromosphere and prominences (for they are parts of a single appendage) present a subject of unsurpassed interest to the student of solar physics. There, if anywhere, will be found the key to the secret of the sun's internal economy; in them, if at all, the real condition of matter in the unimaginable abysses of heat covered up by the relatively cool photosphere, whose radiations could, nevertheless, vivify 2,300,000,000 globes like ours, will reveal itself; revealing, at the same time, something more than we now know of the nature of the so-called "elementary" substances, hitherto tortured, with little result, in terrestrial laboratories.

The chromosphere and prominences might be figuratively described as an ocean and clouds of tranquil incandescence, agitated and intermingled with water-spouts, tornadoes, and geysers of raging fire. Certain kinds of light are at all times emitted by them, showing that certain kinds of matter (as, for instance, hydrogen and "helium" *) form invariable constituents of their substance. Of these unfailing lines Professor Young counts eleven.† But a vastly greater number appear only occasionally, and, it would seem capriciously, under the stress of eruptive action from the interior. And precisely this it is which lends them such significance; for of what is going on there

* The characteristic orange line (D_3) of this unknown substance has recently been identified by Professor Palmieri in the spectrum of lava from Vesuvius—a highly interesting discovery, if verified.

† "The Sun," p. 193.

they have doubtless much to tell, were their message only legible by us. It has not as yet proved so; but the characters in which it is written are being earnestly scrutinized and compared, with a view to their eventual decipherment. The prodigious advantages afforded by great altitudes for this kind of work were illustrated by the brilliant results of Professor Young's observations in the Rocky Mountains during the summer of 1872. By the diligent labor of several years he had, at that time, constructed a list of one hundred and three distinct lines occasionally visible in the spectrum of the chromosphere. In seventy-two days, at Sherman (8,335 feet above the sea), it was extended to two hundred and seventy-three. Yet the weather was exceptionally cloudy, and the spot (a station on the Union Pacific Railway, in the Territory of Wyoming) not perhaps the best that might have been chosen for an "astronomical reconnaissance."*

A totally different kind of solar research is that in aid of which the Mount Whitney expedition was organized in 1881. Professor S. P. Langley, Director of the Alleghany Observatory in Pennsylvania, has long been engaged in the detailed study of the radiations emitted by the sun; inventing, for the purpose of its prosecution, the "bolometer,"† an instrument twenty times as sensitive to changes of temperature as the thermopile. But the solar spectrum as it is exhibited at the surface of the earth is a very different thing from the solar spectrum as it would appear could it be formed of sunbeams, so to speak, *fresh from space*, unmodified by atmospheric action. For not only does our air deprive each ray of a considerable share of its energy (the total loss may be taken at twenty to twenty-five per cent when the sky is clear and the sun in the zenith), but it deals unequally with them, robbing some more than others, and thus materially altering their relative importance. Now, it was Professor Langley's object to reconstruct the original state of things, and he saw that this could be done most effectually by means of simultaneous observations at the summit and base of a high mountain. For, the effect upon each separate ray of transmission through a known proportion of the atmosphere being (with the aid of the bolometer) once ascertained, a very simple calculation would suffice to eliminate the remaining effects, and thus virtually secure an extra-atmospheric post of observation.

The honor of rendering this important service to science was adjudged to the highest summit in the United States. The Sierra Nevada culminates in a granite pile, rising, somewhat in the form

* R. D. Cutts, "Bulletin of the Philosophical Society of Washington," vol. i, p. 70.

† This instrument may be described as an electric balance of the utmost conceivable delicacy. The principle of its construction is that the conducting power of metals is diminished by raising their temperature. Thus, if heat be applied to one only of the wires forming a circuit in which a galvanometer is included, the movement of the needle instantly betrays the disturbance of the electrical equilibrium. The conducting wires or "balance-arms" of the bolometer are platinum-strips $\frac{1}{120}$ of an inch wide, and $\frac{1}{25000}$ of

of a gigantic helmet fronting eastward, to a height of 14,887 feet. Mount Whitney is thus entitled to rank as the Mont Blanc of its own continent. In order to reach it, a railway journey of 3,400 miles, from Pittsburg to San Francisco, and from San Francisco to Caliente, was a brief and easy preliminary. The real difficulty began with a march of 120 miles across the arid and glaring Inyo Desert, the thermometer standing at 110° in the shade (if shade there were to be found). Toward the end of July, 1881, the party reached the settlement of Lone Pine at the foot of the Sierras, where a camp of low-level observations was pitched (at a height, it is true, of close upon 4,000 feet), and the needful instruments were unpacked and adjusted. Close overhead, as it appeared, but in reality sixteen miles distant, towered the gaunt and rifted and seemingly inaccessible pinnacle which was the ultimate goal of their long journey. The illusion of nearness produced by the extraordinary transparency of the air was dispelled when, on examination with a telescope, what had worn the aspect of patches of moss, proved to be extensive forests.

The ascent of such a mountain with a train of mules, bearing a delicate and precious freight of scientific apparatus, was a perhaps unexampled enterprise. It was, however, accomplished without the occurrence, though at the frequent and imminent risk, of disaster, after a toilsome climb of seven or eight days through an unexplored and, to less resolute adventurers, impassable waste of rocks, gullies, and precipices. Finally a site was chosen for the upper station on a swampy ledge, 13,000 feet above the sea ; and there, notwithstanding extreme discomforts from bitter cold, fierce sunshine, high winds, and, worst of all, "mountain-sickness," with its intolerable attendant debility, observations were determinedly carried on, in combination with those at Lone Pine, and others daily made on the highest crest of the mountain, until September 11th. They were well worth the cost. By their means a real extension was given to knowledge, and a satisfactory definiteness introduced into subjects previously involved in very wide uncertainty.

Contrary to the received opinion, it now appeared that the weight of atmospheric absorption falls upon the upper or blue end of the spectrum, and that the obstacles to the transmission of light-waves through the air diminish as their length increases, and their refrangibility consequently diminishes. A yellow tinge is thus imparted to the solar rays by the imperfectly transparent medium through which we see them. And, since the sun possesses an atmosphere of its own, exercising an unequal or "selective" absorption of the same character, it follows that, if both these dusky-red veils were withdrawn, the true color of the photosphere would show as a very dis-

an inch thick, constituting metallic *antennæ* sensitive to the chill even of the fine dark lines in the solar spectrum, or to changes of temperature estimated at $\frac{1}{100000}$ of a degree centigrade.

tinct blue *—not merely *bluish*, but a real azure just tinted with green, like the hue of a mountain-lake fed with a glacier-stream.

Moreover, the further consequence ensues, that the sun is hotter than had been supposed ; for, the higher the temperature of a glowing body, the more copiously it emits rays from the violet end of the spectrum. The blueness of its light is, in fact, a measure of the intensity of its incandescence. Professor Langley has not yet ventured (that we are aware of) on an estimate of what is called the "effective temperature" of the sun—the temperature, that is, which it would be necessary to attribute to a surface of the radiating power of lamp-black to enable it to send us just the quantity of heat that the sun does actually send us. Indeed, the present state of knowledge still leaves an important hiatus—only to be filled by more or less probable guessing—in the reasoning by which inferences on this subject must be formed ; while the startling discrepancies between the figures adopted by different and equally respectable authorities sufficiently show that none are entitled to any confidence. The amount of heat received in a given interval of time by the earth from the sun is, however, another matter, and one falling well within the scope of observation. This, Professor Langley's experiments (when completely worked out) will, by their unequaled precision, enable him to determine with some approach to finality. Pouillet valued the "solar constant" at 1·7 "calories" ; in other words, he calculated that, our atmosphere being supposed removed, vertical sunbeams would have power to heat in each minute of time, by one degree centigrade, 1·7 gramme of water for each square centimetre of the earth's surface. This estimate was raised by Crova to 2·3, and by Violle in 1877 to 2·5 ; † Professor Langley's new data bring it up (approximately as yet) to three calories per square centimetre per minute. This result alone would, by its supreme importance to meteorology, amply repay the labors of the Mount Whitney expedition.

Still more unexpected is the answer supplied to the question, Were the earth wholly denuded of its aëriform covering, what would be the temperature of its surface? We are informed in reply that it would be *at the outside* 50° of Fahrenheit below zero, or 82° of frost. So that mercury would remain solid even when exposed to the rays—undiminished by atmospheric absorption—of a tropical sun at noon.‡ The paradoxical aspect of this conclusion—a perfectly legitimate and reliable one—disappears when it is remembered that under the imagined circumstances there would be absolutely nothing to hinder radiation into the frigid depths of space, and that the solar rays

* Defined by the tint of the second hydrogen-line, the bright reversal of Fraunhofer's F. The sun would also seem—adopting a medium estimate—three or four times as brilliant as he now does.

† "Annales de Chimie et de Physique," tome x, p. 360.

‡ S. P. Langley, "Nature," vol. xxvi, p. 316.

would, consequently, find abundant employment in maintaining a difference of 189° * between the temperature of the mercury and that of its environment. What we may with perfect accuracy call the *clothing function* of our atmosphere is thus vividly brought home to us; for it protects the teeming surface of our planet against the cold of space exactly in the same way as, and much more effectually than, a lady's seal-skin mantle keeps her warm in frosty weather. That is to say, it impedes radiation. Or, again, to borrow another comparison, the gaseous envelop we breathe in (and chiefly the watery part of it) may be literally described as a "trap for sunbeams." It permits their entrance (exacting, it is true, a heavy toll), but almost totally bars their exit. It is now easy to understand why it is that on the airless moon no vapors rise to soften the hard shadow-outlines of craters or ridges throughout the fierce blaze of the long lunar day. In immediate contact with space (if we may be allowed the expression) water, should such a substance exist on our enigmatical satellite, must remain frozen, though exposed for endless æons of time to direct sunshine.

Among the most noteworthy results of Professor Langley's observations in the Sierra Nevada was the enormous extension give by them to the solar spectrum in the invisible region below the red. The first to make any detailed acquaintance with these obscure beams was Captain Abney, whose success in obtaining a substance—the so-called "blue bromide" of silver—sensitive to their chemical action enabled him to derive photographic impressions from rays possessing the relatively great wave-length of 1,200 millionths of a millimetre. This, be it noted, approaches very closely to the theoretical limit set by Cauchy to that end of the spectrum. The information was accordingly received with no small surprise that the bolometer showed entirely unmistakable heating effects from vibrations of the wave-length 2,800. The "dark continent" of the solar spectrum was thus demonstrated to cover an expanse nearly eight times that of the bright or visible part.† And in this newly discovered region lie three fifths of the entire energy received from the sun—three fifths of the vital force imparted to our planet for keeping its atmosphere and ocean in circulation, its streams rippling and running, its forests growing, its grain ripening. Throughout this wide range of vibrations the modifying power of our atmosphere is little felt. It is, indeed, interrupted by

* Sir J. Herschel's estimate of the "temperature of space" was 239° Fahr.; Pouillet's 224° Fahr. below zero. Both are almost certainly much too high. See Taylor, "Bulletin of the Philosophical Society of Washington," vol. ii, p. 73; and Croll, "Nature," vol. xxi, p. 521.

† This is true only of the "normal spectrum," formed by reflection from a "grating" on the principle of interference. In the spectrum produced by refraction, the red rays are *huddled together* by the distorting effect of the prism through which they are transmitted.

great gaps produced by absorption *somewhere;* but, since they show no signs of diminution at great altitudes, they are obviously due to an extra-terrestrial cause. Here a tempting field of inquiry lies open to scientific explorers.

On one other point, earlier ideas have had to give way to better-grounded ones derived from this fruitful series of investigations. Professor Langley has effected a redistribution of energy in the solar spectrum. The maximum of heat was placed by former inquirers in the obscure tract of the infra-red; he has promoted it to a position in the orange approximately coincident with the point of greatest luminous intensity. The triple curve, denoting by its three distinct summits the supposed places in the spectrum of the several maxima of heat, light, and "actinism," must now finally disappear from our text-books, and with it the last vestige of belief in a corresponding threefold distinction of qualities in the solar radiations. From one end to the other of the whole gamut of them, there is but one kind of difference—that of wave-length, or frequency in vibration; and there is but one curve by which the rays of the spectrum can properly be represented—that of energy, or the power of doing work on material particles. What the effect of that work may be depends upon the special properties of such material particles, not upon any recondite faculty in the radiations.

These brilliant results of a month's bivouac encourage the most sanguine anticipations as to the harvest of new truths to be gathered by a steady and well-organized pursuance of the same plan of operations. It must, however, be remembered that the scheme completed on Mount Whitney had been carefully designed, and in its preliminary parts executed, at Alleghany. The interrogatory was already prepared; it only remained to register replies, and deduce conclusions. Nature seldom volunteers information: usually it has to be extracted from her by skillful cross-examination. The main secret of finding her a good witness consists in having a clear idea beforehand what it is one wants to find out. No opportunities of seeing will avail those who know not what to look for. Thus, not the crowd of casual observers, but the few who consistently and systematically *think*, will profit by the efforts now being made to rid the astronomer of a small fraction of his terrestrial impediments. It is, nevertheless, admitted on all hands that no step can at present be taken at all comparable in its abundant promise of increased astronomical knowledge to that of providing suitably elevated sites for the exquisite instruments constructed by modern opticians.—*Edinburgh Review.*

SKETCH OF SIR HENRY ROSCOE.

HENRY ENFIELD ROSCOE, F. R. S., now Sir Henry Roscoe, is a grandson of William Roscoe, of Liverpool, the distinguished merchant-historian, and a son of Henry Roscoe, Esq., barrister-at-law, and was born January 7, 1833. He was educated at Liverpool High School, University College, London, and Heidelberg. He was appointed Professor of Chemistry at Owens College, Victoria University, Manchester, a chair which he has held with distinguished honor to himself and credit to English science, in 1858, and was elected a Fellow of the Royal Society in 1863. His life has been marked by a bright line of investigations in chemistry from which have been derived material additions to the scope and exactness of the science; by numerous addresses before both scientific and popular audiences, and publications in which the breadth and accuracy of his thought are well matched by the clearness and frequent pungency of its expression, and the style is always adapted to the audience the effort is intended to reach; by labors to encourage original scientific research and the presentation of the most exalted aims as its object; and by his activity in the promotion of well-considered practical efforts for the diffusion of scientific knowledge among the people.

The nature of the scientific labors by which he is chiefly distinguished is set forth in the award of the Royal medal made to him by the Royal Society in 1873, which was "for his various chemical researches, more especially for his investigations of the chemical action of light, and of the combinations of vanadium."

The researches on the chemical action of light here spoken of were carried on by him and Bunsen together; and he most modestly refers to them in a biography of Bunsen, published by him in "Nature" of April 28, 1881, as investigations "with the carrying on of which the writer of this article had the great good fortune and pleasure to be concerned, and in which he had full opportunity of admiring Bunsen's untiring activity and wonderful manipulative power."

In the winter of 1866–'67 he started in Manchester a course of thirteen penny scientific lectures for the people, in which he was assisted by Professor Jevons, Dr. Alcock, and Dr. Morgan. The attempt thus made to solve the problem whether the working-men would really appreciate the value of science-instruction when given in a plain but scientific manner, illustrated with diagrams and experiments made on a scale to be seen by a large audience, was highly successful. The lectures were attended by more than four thousand persons of exactly the class for whom they were designed, and they showed themselves interested and appreciative. A syllabus of the chief points of Professor Roscoe's four lectures was printed and given to each person entering

the room ; and phonographic reports of all the lectures were printed and largely sold for a penny each at the door of the hall. This experiment was so successful that it was repeated in the following years ; and when, in 1875, the first six series of lectures, in which many other most eminent scientific men had taken part, were published in three volumes under the supervision of Professor Roscoe, he was able to state that each lecture on the average during the six years had been attended by nearly one thousand persons, and that from five to ten thousand copies of the penny reports of each had been sold, while the demand for back numbers still continued.

The idea of educating the people, especially artisans, in science, is one which Professor Roscoe has held much at heart and on which he has spoken often and to the purpose. Yet he has not failed to see that the problem was a complicated one, surrounded by many difficulties, and that progress in solving it would have to be made deliberately and slowly. In 1871 he wrote in "Nature" concerning a proposition for the establishment of a national working-men's university, to be founded with special reference to instruction in those subjects which have a direct bearing on the arts and manufactures, recognizing the desirabilty of providing for instruction of the kind, but, foreseeing the danger of any attempt to secure it failing, through lack of means or want of good management. He estimated that an income of from £80,000 to £100,000 would be needed to support a people's university on a truly national scale, anything less than which would be a practical failure. But the financial difficulties, he added, were by no means the only or most important ones which would beset the new university. These would only begin to be felt when the scheme had been started —"such as dangers of giving an instruction too purely theoretic, or of running into the worse evil of teaching details without scientific *aperçu.*"

A few years after this, we find him engaged in a discussion respecting the teaching of science in schools, in which he supported the position that no satisfactory advantage could accrue from this sort of instruction, until the subject was "placed upon its true position of *educational equality*, both as regards range and time, with classics and mathematics, and no system of regulations or of examinations can be said to fulfill its object in which this position is ignored." "I am fully aware," he said, in another letter, "of the importance of a firm mathematical foundation, and I am far from wishing to overwhelm the younger boys with science before they have mastered the elements of arithmetic and grammar and languages. . . . The mistake, as it seems to me, which is prevalent respecting science-teaching in schools, is the notion that it is a subject to be *lectured* upon for two hours per week to those already educated, and who show an aptitude for it, while it can and ought to be introduced at a definite period as a regular part of *school-work.* It is now usually made an extra subject, a *quasi-*

amusement, put on the same footing as drilling or drawing, while it can and ought to be made as much a discipline as the Latin grammar or Euclid, affording as it does, in my opinion, if properly taught, an excellent training-ground for acquiring that reasoning power and habit of application which it is usually supposed can only be gained through one or other of these older channels. . . . The Balliol scholarship and the other great university 'advertisements' I believe to be in many ways stumbling-blocks in the path of true education in this country. . . . Are we never to break loose from this degrading Moloch of examination? I . . . look forward with hope to the ultimate emancipation of school-boys from their ancient fetters. Then those subjects will be taught at school which are best suited to make the mass of boys good citizens, and to forward the highest interests of the country instead of the great aim of the schoolmaster being to secure a Balliol scholarship."

His views of the scope, objects, and benefits of science were presented in his address at the opening of the new building of Owens College, Manchester, in 1873, the subject of which was "Original Research as a Means of Education," when he said:

"It does not take long to convince us that almost every great material advance in modern civilization is due, not to the occurrence of hap-hazard or fortuitous circumstances, but to the long-continued and disinterested efforts of some man of science. Nor do I need to quote many examples to show us the immediate dependence of the national well-being and progress upon scientific discoveries thus patiently and quietly made."

In other parts of this address he laid down these principles:

"The essence of the scientific spirit is, first, that it is free and disinterested; second, that it knows nothing of tradition or authority, but lays down laws for itself, and refuses to be bound by any others. Scientific education starts in simple communion with Nature, and is content to pick up little by little the truth which she is always ready to communicate to patient listeners. The process is at once opposed to and, if successfully carried out, subversive of the old order of things. Between a system based on authority and one founded on freedom of thought and opinion, there never can be united action; and, while fully acknowledging that intellectual and moral excellence are common to all classes of men, it is as well that we should admit that the followers of the old system have no claim to be called scientific, and that there is, from the nature of things, a great and impassable gulf between us and them. I must, however, here be not misunderstood. It would ill become me . . . to undervalue or depreciate the study of subjects other than those included under the head of the physical sciences. Literary studies, whether of modern or ancient authors, giving an acquaintance with the noblest thoughts and opinions of the great men of past ages; historical studies, giving us a knowledge of the acts of men in times

gone by ; the study of language and philology, as giving a knowledge of how men of all times and countries express their ideas and language ; of logic, as pointing out the laws of thought ; and, above all, that of mathematics—are all matters of the highest importance, the neglect of which would render our education incomplete and poor indeed. The same rules, however, which all acknowledge to be necessary for the teaching of physical science must be applied to the study of all these subjects. In short, the *scientific* method must be employed in all cases and carried out to its fullest extent." He followed these observations with a protest against the supposed materialistic tendency of scientific studies, saying : "It is true that certain opinions and professions of belief have been and will be shaken by studying the book of Nature ; it is also equally true that the study of Nature does not and can not interfere with the highest and noblest aspirations of the mind of man. In the investigations of every branch of science we come at last to a point at which further inquiry becomes impossible, and we are obliged to acknowledge our powerlessness and insignificance. We can see and learn concerning only the minutest fraction of the great whole of Nature, and it is with this minute fraction alone that we, as men of science, are concerned."

Speaking of the advantage of experimental scientific research, he said that the faculties which are called into operation by its prosecution "are, in fact, exactly those which are valuable in the every-day occurrences of life, the proper employment of which leads to success in whatever channel they may happen to be directed. A man who has learned how successfully to meet the difficulties and overcome the obstacles which occur in every experimental investigation, is able to grapple with difficulties and obstacles of a similar character with which he comes in contact in after-life. It is the greatest possible mistake to suppose—as, unfortunately, many yet do—that a scientific education unfits a man for the pursuits of ordinary professional or commercial life. I believe that no one can be unfitted for business life or occupations by the study of phenomena all of which are based upon law, the knowledge of which can only be obtained by the exercise of exact habits of thought and patient and laborious effort."

Further, concerning the ennobling nature of original scientific inquiry : "Although I should be the last to contend that men of science are free from the foibles and weakness common to all mankind, I think it stands to reason that the habits of mind which an investigator must cherish are such as must raise him above the petty struggles of ordinary existence, and must, for a time at least, lift him into an atmosphere free from the cloud and smoke which too often darken the usual current of men's lives."

In his opening address to Section B, of the British Association, in 1870, he spoke of a humane and civilizing mission which science might accomplish aside from its direct end, saying, after a reference to the

Franco-Prussian War, then in progress: "And here may I remind you of the cosmopolitan character of science, of the fact that it is mainly to the brotherly intercourse of those interested in science, and in its application to the arts and manufactures in different countries, that we must look as the small but living fire which in the end will surely serve to melt down national animosities, and to render impossible the breaking out of disasters so fatal to the welfare of humanity as that of which we are now unfortunately the spectators?"

Besides the researches to which reference has already been made, and numerous papers in the "Philosophical Transactions" and the scientific periodicals, Professor Roscoe has published "Lessons in Practical Chemistry," a work which has been translated into German, Russian, Hungarian, and Italian, and republished in this country; "Lectures on Spectrum Analysis," of which a fifth edition was published in 1878; a "Junior Course of Practical Chemistry," prepared by himself and Francis Jones in 1873; and, conjointly with Professor Schorlemmer, a large "Treatise on Chemistry," in three volumes. The last work was pronounced by "Nature," in a review of the first two volumes, one which, "when finished, will afford the most complete systematic exposition of the existing state of chemical science that has yet appeared in the English language"; and by Professor Watts as forming a treatise on inorganic chemistry "of which English science may well be proud." To "Nature" he contributed affectionate biographies of Liebig and Bunsen. He was also joint editor, with Professor Huxley and Balfour Stewart, of Macmillan's "Science Primer" series, and author of the "Primer of Chemistry." He is Examiner in Chemistry to the Science and Art Department. He was elected President of the Chemical Society of London in 1880, President of the Literary and Philosophical Society of Manchester in 1882; and is a member of the Royal Commission on Technical Instruction. He was knighted in 1884, at about the time of the meeting of the British Association at Montreal.

EDITOR'S TABLE.

HARRISON AND SPENCER ON RELIGION.

WE print the concluding portion of a controversy between Frederic Harrison and Herbert Spencer on the nature of religion. In an article which appeared in the "Monthly" of last January, Mr. Spencer took a retrospective view of the past tendencies of religious ideas, and on the basis of this pointed out the further changes that may be expected in the future. His conclusion was a reaffirmation of views laid down many years ago, that there is a verity at the foundation of all religious systems, which will permanently remain when the erroneous beliefs accompanying this verity are utterly swept away by the progress of science. Mr. Spencer thus arrays himself, not with those who deny but with those who affirm the validity of religion, or that there is a reality at the root of all the diverse, discordant, and changing faiths professed by mankind. Religion is held to pertain to the sphere of the emotions, and to consist essentially in the feelings which arise in human nature toward the unsolved and forever insoluble mystery of the universe. Mr. Spencer says that, "unlike the ordinary consciousness, the religious consciousness is concerned with that which lies beyond the sphere of sense." It therefore relates to that which can not be grasped by the intellect, but which lies beyond the range of knowledge. That which is the object of religious feeling can not be known in any sense of our usual knowledge. Mr. Spencer reasons that it is not a negation, but a positive reality; and, preferring to use a term connotive of true humility and the limitations of the human mind, he calls this mysterious object of religious feeling "The Unknowable."

Mr. Harrison attacked this view of Spencer in an article which appeared in the August "Monthly" under the title of "The Ghost of Religion." He maintained that Mr. Spencer had perpetrated an utterly destructive criticism of everything hitherto known as religion; and argued that the attempt to find anything like a common element in religious systems is futile, while the doctrine of the Unknowable is but a vain attempt to deify an all-nothingness. His position, therefore, was, that there is no element of truth whatever in any of the systems that have passed under the name of religion. Yet Mr. Harrison will not give up the term religion. He proposes to retain it, redefine it, and make a new application of it. He says it is duty, virtue, morality, and finds its highest expression in a worship of humanity.

Mr. Spencer rejoined to this criticism in an article printed in the same number of the "Monthly," under the title of "Retrogressive Religion." He replied to Mr. Harrison's criticisms of the doctrine of the Unknowable, and then subjected to a close examination Mr. Harrison's view of the Religion of Humanity. Mr. Harrison replies in an article entitled "Agnostic Metaphysics." It is very long, and divided into three parts. The first contains all that is essential to the main controversy; and, as we can not afford room for his less important expansions of the discussion, we print herewith the first portion, which is all that is properly covered by his title, and the part to which Mr. Spencer's answer is chiefly confined—which answer also appears in the present "Monthly."

We have felt bound to lay this discussion before our readers, because it is undoubtedly of profound importance. It goes to the root of the issue be-

tween science and religion, and is really a contest over the vital question whether there is, or is to be in future, any recognition of any such thing as truth in the religious sphere of human experience. In the issue as thus made up, Herbert Spencer is on the religious side. He affirms that man is a religious being, that the religious sentiments have their proper object, that science can carry away only errors of theological belief, and that the basis of religious feeling must be as permanent in the future as it has been in the past. This Mr. Harrison denies, and maintains the absolute groundlessness of all religious conceptions or sentiments which have been embodied, however obscurely, in the past beliefs and aspirations of mankind.

Mr. Harrison says that he warned Mr. Spencer ten years ago that "his religious doctrine of the Unknowable was certain to lead him into strange company." The apprehended danger was, that the ground taken by Spencer on religion might at length find acceptance with religious people, and now he intimates that this disaster, against which he raised his voice of warning, has actually occurred; that is, religious people are coming into agreement with Mr. Spencer. We indulged in a similar prophecy more than twenty years ago, though in no spirit of dread or warning. We said that as science went on with its inexorable work of criticism, undermining and overthrowing theological errors, the stern question would certainly arise whether anything whatever was to be left; and that there would then be a far higher appreciation of the position taken by Spencer, that the essentials of religion are indestructible in human nature. For maintaining this doctrine in the form which he gave it, Mr. Spencer was denounced as a materialist, an atheist, and the destroyer of religion. But, now that his views are better understood, it begins to be acknowledged on the one hand that he has rendered a great service to the religious side, while the undisguised enemies of all religion are making war upon him because there is a tendency among the most enlightened religious people to favor his ideas. Yet the whole burden of Harrison's argument is to show that the doctrine of the Unknowable is inadequate as a religious basis, because the people will never be able to appreciate it. But time may rapidly change the possibilities of appreciation as implied by his own warning of ten years ago, which he now declares is being fulfilled. It is to be remembered that Mr. Harrison does not deny, but virtually concedes, the validity of the doctrine of the Unknowable as a logical formula or philosophical proposition, which, of course, is to admit that there is truth in it. But he says it belongs to philosophy, and denies that it has or can have any religious significance. Yet Mr. Spencer has proved that it is the fundamental and central truth of all the religions that have existed and had power over mankind. Mr. Harrison can not deny the essential religious character of this view without vacating the fundamental conception of religion and uprooting it from human nature. This he aims to do in his discussion, and then coolly proceeds to put something else in its place.

There therefore can be no hesitation about classing Mr. Harrison as an inveterate antagonist of religion. Taking the meaning that the world has hitherto given to the word, he scouts it as pure illusion. Yet he will not admit that he is the enemy of religion. As we have said, he believes in and is laboring to found and extend a new religion. We only complain that in doing this he wrests the word from its old and established meaning and gives it a novel and perverted application. In place of the religions which have made the Divine Power an object of worship, he would substitute the worship of

man and the religion of humanity as invented and expounded by Comte. Of course, the new view can only be accepted by the abandonment of the old, and we very much doubt if the world will approve or accept the change. It is incongruous and fantastic, and would be incredible, but for the ridiculous fact that a little sect is actually trying to adopt and carry it out. A writer in an English newspaper, who had visited the Little Bethel of the Comteists to witness the services on the eve of the *fête* of the founder of the new religion, thus describes what he saw: "When I entered Dr. Congreve was reading the service for the day. He had an audience of some thirty persons, several of them young ladies who had evidently come to be startled. The sermon was preached by Mr. Crompton. If he is a 'priest' of the new dispensation, he wears no clerical attire. Perhaps the year 96 of the Comteist era (for they have, like the French Republic, their own era) is too early for the invention of sacerdotal robes. The preacher came to a desk draped in red baize, and for a half-hour poured forth a rhapsody upon Auguste Comte, Clothilde de Vaux, progress, order, unity, and love, which was chiefly remarkable for the free use of Christian language to set forth a faith (if it can be called a faith) antagonistic to Christianity. The poor wife of Comte, who left him, was dismissed with a word of scorn for one who was incapable of sharing the honors of greatness; and Clothilde, the mistress, was extolled to the skies for her devotion to her distinguished lover. Comte and Clothilde were declared to be the two greatest people who had visited this earth; and the peroration was a sort of ascription to them. It was startling to hear the organ, as the preacher sat down, peal forth that beautiful phrase from Mendelssohn's 'Elijah' so often heard as a Kyrie, and associated in the oratorio with the words 'Bend down from heaven and grant us thy peace. Help, Lord, thy servants; help, O God!' Dr. Congreve then rose and said, 'Let us pray.' Everybody stood. 'We praise thee, Humanity,' said Dr. Congreve, 'as for all thy servants, so especially for Auguste Comte; and we pray that, in proof of our gratitude, we may become thy more willing and complete servants.' The prayer went on to talk of 'the queen of our devotion, the lady of our loving service, the one center of all our being, the one bond of all ages, the one shelter for all the families of mankind, the one foundation of a truly catholic church. To thee be all honor and glory. Amen!' Then came a parody of the benediction given in the name of Humanity: 'The peace of her slowly dawning kingdom be upon you, the blessing of Humanity abide with you, now and forever.' The organ played again, and the little audience departed."

The devotees of this new religious cult may be sincere, but they are none the less absurd; and to call this result of insane egotism—the substitution of man for God as an object of worship—by the name of *religion*, is to take liberties with the meanings of words which, if carried out, would reduce all language to a state of chaos.

A HEALTHY MATERIALISM.

In spite of the intellectual advancement of our age, men are still to far too great an extent under the dominion of mere words. If there is any habit which science is destined to break up and dispel it is this. Science must do it, because it is pre-eminently the knowledge of things, and to know *things* should make the mere *names of things* sit lightly upon one. Words have seized the throne of man's reason; they command, and he obeys. It is time to dethrone them, to break their spell over the human mind, to teach every human being to ask without dismay: "What is the reality of

this thing to which so terrible — or mayhap so imposing or so attractive—a name is given? Let us not stop at the name; let us get at the facts."

Now, one of the most appalling terms —to some—of modern philosophical discussion is "materialism." To others —a much smaller number—it stands for the only true scientific gospel. We think, therefore, that we shall be rendering a useful service if we try to show, and succeed in showing, as we think we can, that there are two kinds of materialism—one a healthy kind which has an unshakable foundation in Nature, and which no one need dread to accept; the other an unhealthy kind that fortunately has no foundation anywhere, but exists as a wholly illegitimate construction in the minds of those who cherish it.

What matter is we know not, and do not need to know. We know how our minds are impressed when we speak of matter; we know, in other words, what kind of consciousness we have when matter is an object of thought or feeling. In the same way, without knowing what mind is, we know what we are conscious of when we think of mind. Now, if there is anything in this world we are sure of, it is that mental manifestations are governed by physical conditions. It is needless to go over the familiar arguments, when any one who disputes the general position is found talking to a drunken man just as he would to a sober one, or to a delirious patient just as he would to a person in sound health—in other words, taking no account of the physical conditions which have confused the mental operations of either unfortunate—then we shall believe that he means what he says; only, we may then have to conclude that he is either drunk or delirious himself. Further, we know that mental constitutions, like bodily ones, are inherited. We expect children to resemble their parents in character as well as in person. We expect to find, and do in general find, certain broad national characteristics in people of a certain race. We look for enterprise and tenacity in the Anglo-Saxon stock; we look for a predominant emotionalism in the Celtic; we look for ready submission to power in Eastern races; we look for alternate restlessness and indolence in our Indian tribes. All this simply means that mind manifests itself under quite as definite forms as any of the phenomena of the physical universe, and that we know where to look for each variety. Again, mental powers and aptitudes depend to a considerable extent on education and upon the opportunities that life brings with it. We do not expect, in matters intellectual any more than in matters agricultural, to reap where we have not sown, or to gather where we have not strewed. The experience of that ancient saint who woke one fine morning, and found himself in full possession of half a dozen languages of which the day before he knew not a word, is not repeated in modern times. Nowadays, we have to learn before we know.

The dependence, therefore, of mind, or at least of its manifestations—and of nothing else do we know anything—on physical or material conditions may be taken as an incontrovertible fact. If, therefore, the term "materialism" had been confined, as it might have been, to the expression of this fact, would there have been anything terrible in it? To use Comte's illustration, would any one think it a dangerous concession to make to admit that he could not work out intellectual problems to advantage standing on his head? Surely the materialism which teaches a man that, if he would exercise his mind to advantage he must eat moderately, and in general economize his physical powers, is not a very deadly doctrine. Yet that doctrine might very aptly and properly be called materialism; just as we call spiritualism the converse doctrine that, if a man wants a piano or

other heavy body lifted without taxing any one's muscles, the best way to do it is to hire a medium who will engage a disembodied spirit to do the job. Materialism in the sense above limited, far from threatening any injury to or derogating from the dignity of mind, is the very thing that will most help to bring mind to the highest perfection, while it promotes its dignity by making all material things subservient to it.

But there is another point of view. This doctrine, far from being of a radical and disturbing kind, is eminently conservative and favorable to intellectual order. Why? Because it establishes the truth that mind is not an unconditioned entity, as some are inclined to regard it, but a thing strictly conditioned and limited. The world ought by this time to have got over the old metaphysical notion of the absolute independence of mind, but it has not, in point of fact, got over it; and, strange to say, some of those who hold most strongly to the old error are professed freethinkers. In fact, we are not sure but that the ranks of technical "free-thought" are to day the very citadel of that error. It seems to be continually assumed that the vindication of the right of free-thought carries with it an assertion of the *competency* of every man's thought for all possible intellectual enterprises. Here we see the old idea of the mind as a kind of impalpable essence of absolutely unlimited powers, tethered neither to time, to place, nor to circumstances. But supposing the opposite truth were universally and frankly recognized, that each man's mind was simply what circumstances past and present had made it, a man would not in claiming free thought feel, as so many do now, that he was asserting his right and his competency to deal with all problems in heaven and on earth, but simply that he was asserting his right to exercise that *limited* activity for which his mind was adapted. A man whose body was in durance would not, in claiming physical liberty, fall under the illusion that if he could once gain his liberty he would be competent with his body to perform all manner of gymnastic feats. No; because he knows what his body is fit for, what it has been trained to, and what lies altogether beyond its powers, natural and acquired. If, when he had obtained his liberty, somebody wanted him to attempt at once, by way of marking and emphasizing his perfect freedom from physical control, some very difficult and dangerous athletic feat to which he had never been accustomed, he would be wise if he turned a deaf ear to the suggestion; or, rather, he would be an extraordinary fool if he listened to it. Yet it will scarcely be maintained that exactly similar folly is not often practiced by way of emphasizing freedom from mental control—that is to say, that men rush at the most difficult intellectual problems without any preliminary consideration of the question of their competency for dealing with them successfully or hopefully. As long as they arrive at some conclusion which they can fling in the faces of their supposed opponents as a trophy of free-thought, they are satisfied. The remedy for this kind of folly is plain. It lies in the "materialistic" doctrine, as we claim the right to call it, that the mind is as limited a thing as the body, and that *therefore* we can not properly assign any more extensive meaning to freedom of the mind than we do to freedom of the body. Both kinds of freedom are good, but neither confers new powers, except in so far as the exercise which freedom makes possible tends to develop power. Power, however, is only developed by rational exercise; bodily growth can be arrested, and the bodily frame twisted out of shape, by excessive or ill-directed exercise; and precisely so with the mind. While, therefore, we have all possible sympathy with the claim for freedom of thought, we wish we could always

be certain that those who make the claim were "materialistic" enough to recognize that they were claiming the right to exercise faculties of a strictly limited kind, the particular limitations varying from man to man, and that they must not expect the world to look on with admiration at attempts to make mere "freedom" supply the place and do the work of knowledge and competency. To all of every school who adhere to the old metaphysical views of mind, and who hold themselves possessors of an organ of unlimited powers, we would say: "You are under an error; your mind is tethered to your body, it is tethered to its own past history, it is tethered to a long line of ancestry. Some things it can do, because they fall within its tether; others it can not do, because they fall beyond. Be wise, try to find out what your limitations are, and proportion your intellectual tasks to the width of your intellectual shoulders." Such are the teachings of a healthy materialism, at once the most conservative and the most progressive of doctrines.

POLITICS AND SCIENCE.

The collocation of ideas expressed in this title is not generally regarded as valid or established; but they are unquestionably coming every day into closer relation. The recent campaign, at any rate, is full of suggestion in regard to important principles with which it is the office of Science to deal in the working of practical politics.

The scientific habit of mind is that, above all, which links cause with effect and effect with cause, and which, in special phenomena, seeks always to discover the illustration of some general law. In the recent contest the excitement was almost unparalleled. For a time the whole nation was in a condition which, in the physical life of the individual, would be represented by a state of high fever. We have heard a good deal about "the splendid conduct of the people," and certainly it spoke well for the sense of responsibility of the citizens generally that they refrained from acts of disorder. It is, however, a question whether there was anything very admirable in the excitement itself, or in the causes of it. It is a further question of much gravity whether such periods of excitement can be repeated with safety. Can we count upon the same admirable self-control on future occasions, particularly when we consider how little confidence each party seems to possess in the honesty and fair-dealing of the other? These are serious questions and call for an answer from every thoughtful citizen.

The excitement of the late contest was largely due to the fact that it was a conflict not so much of principles as of interests. We are not prepared to deny that a large number of citizens in the aggregate had their own serious views of public policy in connection with the election; but these were not among the most excited members of the community. A man who has faith in a principle will work for it, and be enthusiastic for it, but he can afford to bide his time. It is the man whose whole course is determined by party allegiance, and who has learned to recognize his political opponents as enemies, not so much of his views as of his interests, who is carried away by a kind of frenzy in times of political crisis. Such men unfortunately constitute the great majority, and hence the danger which waits upon presidential elections. The practical question which confronts us, then, is how this blind devotion to party is to be counteracted. How are men to be made ashamed of resigning their whole individuality to political leaders, who themselves are often no better than political adventurers? It is evident that what we need is an increase of intelligence in the community. We flatter ourselves, of course, that we are the most intelligent community in

the world; but, however the comparison may hold between ourselves and other nations in this respect, it is evident that we want more intelligence, more of true culture, and that such intelligence, such culture, is the only influence on which we can depend to moderate the passions which our civic contests are so prone to generate. It is to science we must look for help—to science in its widest and noblest sense. A man may possess much technical knowledge, and his practical judgment may remain narrow, and his moral nature commonplace, if not absolutely inferior. The science that elevates is not the science which is taught or learned merely as a means of gaining a living; it is not the science that sharpens greed and gives a more cunning acquisitiveness; it is the science that enables a man to live in an atmosphere of general ideas, and that makes the whole world interesting to him apart from all purely personal concerns. It is science in this sense that should be brought to bear upon the minds of the young in our schools and colleges. It is science in this sense that we contend for as an integral part of all education. It is for the lack of general scientific conceptions, supported by a basis of solid knowledge in some particular branch or branches of science, that men are to-day so largely the prey of political demagogues, and come so near losing control of their actions in times of excitement. The lesson of the election is, that our national culture is but a shallow culture, considering the vast and even dangerous responsibilities devolving upon the individual citizen. Granting even that other nations can manage to do with no higher a development of intelligence, with a distribution of knowledge no more liberal than that which exists in this republic, it does not follow that we can safely be content with our present attainments in these respects. It is well for us that the next presidential election is four years ahead. Let the intervening four years be years of earnest struggle for the advancement of science, for the spread of a true culture, that in our next crisis the influence of ideas may be a little, if ever so little, greater, and that that of personal passions a little, if ever so little, less.

LITERARY NOTICES.

A Compend of Geology. By Joseph Le Conte, Professor of Geology and Natural History in the University of California; author of "Elements of Geology," etc. New York: D. Appleton & Co. Pp. 399. Price, $1.50.

This is the third volume that has appeared of the new and attractive series of "Appletons' Science Text-Books." The great popularity and success of the author's larger work for colleges led to the belief, expressed by many, that he would be the best man to prepare a shorter work suited to general school use. Such works should certainly not be left to compilers, on the pretext that general introductory books are of less importance than advanced treatises. It is desirable, first of all, in preparing a good text-book, small or large, that the author should know his subject, directly and thoroughly, and then that he should be capable of presenting it in a form adapted to the grade of students for whom it is written. Professor Le Conte is a high authority in geology, a life-long student of American geology, and an examination of the present work convinces us that he has remarkable tact and judgment in adapting his exposition to the grade of mind for which this volume is intended. It is not a *primer* of geology, and makes no attempt to reduce the order of ideas, with which this science is conversant, to the capacities of children. It implies the usual mental maturity of scholars in our schools fifteen or sixteen years of age, and to these the book is made thoroughly intelligible by the effort required in class-room study. It is properly a book for beginners, and at the same time presents a view of the subject sufficiently full and complete for the general purposes of education. It is written in a simple, clear, and popular style, and is so abundantly illustrated as to

afford every advantage of pictorial representation. At the same time the work would prove valuable as an authentic account of the present condition of geological science for general reading and convenient reference.

Like all the other volumes of this series, it is presented in an elegant form and finished workmanship, alike in engraving, typography, and binding. Le Conte's compend should at once take rank as a standard school text-book.

The Destiny of Man, viewed in the Light of his Origin. By John Fiske. Boston: Houghton, Mifflin & Co. Pp. 121. Price, $1.

It was certainly not at all surprising that Mr. John Fiske should have received an invitation to lecture before the "Concord School of Philosophy"; but it was a matter of some surprise to many that he should have accepted it. There are those who will think he was not at home there; and yet there seems to have been a propriety both in the invitation and in the acceptance of it. The Concord philosophers this year took up the question of immortality, and, as Mr. Fiske has views upon this subject, and as his opinions upon any grave philosophical question are highly valued, and as, moreover, there is a good deal of interest to know how he regards this particular problem, the Concord people must be credited with doing an excellent service in calling him out.

We shall here be able only to state Mr. Fiske's position, as to discuss his views will require a formal article; and we can not better indicate the ground he takes upon the question of immortality than in his own words in the preface, which will also afford a clew to its treatment in the book. He says: "The question of a future life is generally regarded as lying outside the range of legitimate scientific discussion. Yet, while fully admitting this, one does not necessarily admit that the subject is one with regard to which we are forever debarred from entertaining an opinion. Now, our opinions on such transcendental questions must necessarily be affected by the total mass of our opinions on the questions which lie within the scope of scientific inquiry; and from this point of view it becomes of surpassing interest to trace the career of humanity within that segment of the universe which is accessible to us. The teachings of the doctrine of evolution as to the origin and destiny of man have, moreover, a very great speculative and practical value of their own, quite apart from their bearings upon any ultimate questions. The body of this essay is accordingly devoted to setting forth these teachings in what I conceive to be their true light; while their transcendental implications are reserved for the sequel."

From this it will be seen that Mr. Fiske's volume affords a compendious presentation of the doctrine of evolution in its highest aspects as throwing light upon the origin, history, career, and possible destiny of man. As an exposition of this subject the little book is a gem of lucidity and instructiveness. Mr. Fiske has but very few peers as a clear, attractive, and brilliant writer; and on the subject here treated he writes with the authority of one who by his independent and original investigations has aided in giving shape to modern evolutionary doctrine in its higher aspects. The book is to be very strongly commended on this ground, and is certain to be widely read. The incompleteness which is a necessary result of its brevity may be supplemented by reference to the more elaborate presentation of his views in his other works; and at the close of the volume he indicates which of his larger volumes is to be consulted for this purpose and where the more elaborated opinions are to be found. Without inquiring at present into the validity of the special conclusions he has arrived at on the question of immortality, we will only say that the book taken in connection with its references is a unique and incomparable statement of evolutionary doctrine, that may be perused with equal pleasure and profit by all concerned in this class of inquiries.

Shoppell's Building Plans for Modern Low-Cost Houses. Edited by Robert W. Shoppell. New York: Co-operative Building Association. Forty Plans. Price, 50 cents.

The houses for which plans are given are in the favorite styles of the day, and range in cost from $400 to $6,500. The designs are furnished by Stanley S. Covert and Fran-

cis K. Kane, architects. The publishers assert that being architects they are prepared to back up every profession made in the work; and that the costs of construction furnished may be relied upon. "Even in far-distant places and after the lapse of years," they say, "we can still make the prices good by some change in construction or material when making the working plans and specifications." This on condition, of course, that their working plans and specifications are obtained, for which they make a special charge of from $12 to $60, according to the character of the design.

My Farm of Edgewood. By the author of "Reveries of a Bachelor." New York: Charles Scribner's Sons. Pp. 329. Price, $1.25.

"My Farm of Edgewood" is, reckoning from the day of its first appearance, twenty-one years old; but it is not an old book. The world has seen changes since it was first published. American suburban life is very different from what it was then. Agriculture has made advances, and science has been revolutionized in some of its branches. But "My Farm" is as fresh and as timely as was the first copy damp from the press; and it seems destined to live a classic. It is a pastoral, a picture of an ideal life, which is also real, seen as with a poet's eye; while, on the other side, it gives a correct vision of farm-life with its bright and dark features, abounds in graphic social sketches, and is so permeated by common sense that its suggestions are capable of being made practically applicable to the concerns of common life.

Forestry in the Mining Districts of the Ural Mountains in Eastern Russia. Compiled by John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 182.

The plan of this treatise is not essentially different from the plans of the author's previous works on the forestry of the different European states. It divides itself into two parts—forestry west and forestry east of the Ural Mountains. In the second section, besides the condition of the forests and forest exploitation, information is given on the mining enterprises of the eastern slopes of the Ural Mountains. In a curious chapter on "Abuses in Connection with the Exploitation of the Forests," revelations appear of the corruptibility of the Russian officers, and of the tricks to which they resort to enrich themselves without seeming to take bribes.

Comprehensive Anatomy, Physiology, and Hygiene. By John C. Cutter. Philadelphia: J. B. Lippincott & Co. Pp. 376.

The author of this work, which is adapted for schools, academies, colleges, and families, is professor of Physiology and Comparative Anatomy in the Imperial College of Agriculture at Sapporo, Japan. In the instruction of his pupils, whose knowledge of English was not perfect, he was led to depend less upon the text-book and more upon dissections before the class, and upon demonstrations from an active coolie, and from microscopic preparations; and his book has grown up out of this method of teaching. It contains, together with the outlines of the principles of the science, brief directions for illustrative dissections of mammals, for elementary work with the microscope, for physiological demonstrations on the human body, and for the management of emergent cases. The effects of stimulants are treated without bias in the chapter on that subject. The effort is made to give all the information a practical direction.

N. W. Ayer and Son's American Newspaper Annual. Philadelphia: N. W. Ayer & Son. Pp. 994. Price, $3.

The "Annual" contains a carefully prepared list of all newspapers and periodicals published in the United States, the Territories, and the Dominion of Canada, with information respecting them and concerning the character, population, politics, resources, manufactures, and products of the places in which they are published, classified, arranged, and rearranged, in various ways. An idea of the composite character of our population is conveyed by the presence in the lists of nearly five double-columned pages of titles of German publications, not quite a page of French, 53 Scandinavian, 35 Spanish and Portuguese, 12 Bohemian, 11 Hollandish, 7 Italian, 3 Polish, 5 Welsh, one Irish, one Latin, and one Hungarian periodicals.

How we Live; or, the Human Body, and how to take care of it. By James Johonnot and Eugene Bouton, Ph. D. New York: D. Appleton & Co. Pp. 162. Price, 50 cents.

This book presents an elementary course in anatomy, physiology, and hygiene. Its method is deductive, each new topic growing out of the one that precedes it; and it aims to present the laws of life in such a practical and reasonable way that they will become a guide to living. In the treatment of each topic, function is considered before structure, and the endeavor is made to present the relations of part to function in such a way that the hygienic law applicable to the case shall follow as a matter of course. As an incentive to study, the authors have appended at the close of each chapter a list of questions on subjects suggested by the text, which will prompt the pupil to think and observe for himself.

Book of Cats and Dogs and other Friends, for Little Folks. By James Johonnot. New York: D. Appleton & Co. Pp. 96. Price, 20 cents.

The object of this book, with its entertaining stories, its extracts from Mother Goose, and its beautiful illustrations, is the pleasure and the instruction of children, and it is well adapted to it. Through their love of pets, of stories, of jingle and fun and incongruity, says the author, their little opening minds "may be led to careful observation, comparison, and descriptions—steps at once necessary to mental growth, and leading up to the portals of science. By insensible degrees, play may be made to merge into study, and fun take on the form of fact. Upon these ideas of the basis and method of thought, this little work has been constructed." The "other friends" include horses, cattle, sheep, goats, and pigs.

The True Issue, New York, G. P. Putnam's Sons, pp. 79; and Wages and Tariffs, pp. 47, by E. J. Donnell, New York, Wilcox & O'Donnell Company. Price, 10 cents.

In the former of these pamphlets, Mr. Donnell maintains that industrial depression and political corruption result from the existence of great monopolies which are fostered by the tariff. He endeavors to show that the wool-tariff is suicidal, the tariff on manufactures a sham, and that there has been no steady, genuine prosperity since the present high protective policy began. He calls iron the key to the arch of monopoly, and says it is the article with which tariff reform should begin. He suggests that, if a bounty should take the place of the tariff, the people would see what protection costs them, and whether the return justified the expenditure. In "Wages and Tariffs," which is an address delivered before the Brooklyn Revenue-Reform Club, May 8, 1884, he gives some account of protective legislation in this country, aiming to show that its effect, especially on wages, has been mischievous.

Outlines of Roman Law. By William C. Morey, Ph. D. New York: G. P. Putnam's Sons. Pp. 433. Price, $1.75.

The importance of the Roman law as a part of liberal education has been strongly emphasized of late years in England, and has received some recognition in this country. It seems now to be a well-established fact that the history of modern systems of law, and the principles of comparative jurisprudence, can not be properly understood without some knowledge of that branch. The validity of this statement, which we give almost in Mr. Morey's words, becomes obvious when we reflect that the Roman law comprised a highly perfected and elaborate system of jurisprudence that covered the whole extent of the empire through many centuries, and which avowedly constitutes the foundation of the legal systems of nearly all civilized states. The law of all Europe, except Russia and England, is built directly upon it. Recent investigations have shown that it has had much more to do with the structure of English law than the old text-books taught, and that the common law, though further removed in descent than the civil law, was in its essential features a legitimate outgrowth from it. In the United States it appears in its full force in the jurisprudence of Louisiana, which is of the civil and not of the common law, and in modified forms in the institutions of the other States, derived from the common law. Professor Morey's treatise is first historical, considering the growth of the Roman law

in four periods down to the codification by Justinian, and in a fifth period to the present time. In this part are given accounts of the study of the law and its force in different States. The second part of the book discusses the general principles of the Roman law under the heads of the law of persons, the law of things, and the law of actions.

A Thousand Questions in American History. Syracuse, N. Y.: C. W. Bardeen. Pp. 247. Price, $1.

This book presents an outline of the history of the United States in the form of questions and answers. It was prepared by a teacher for use in his own school, and deals not merely with events, but with causes, and with the side issues that have played important parts in American politics. It may be found a useful aid to teachers in directing their attention to the events and aspects of events on which they can make their classes dwell with the most advantage.

The Book of Plant Descriptions: or, Record of Plant Analyses. By George G. Groff. Lewisburg, Pa.: Science and Health Publishing Company. Pp. 100. Price, 35 cents.

This is a book of blanks, for the botanical descriptions of plants as elucidated by the student in his analyses. Each plant is given a page, containing skeleton forms, to be filled in, in separate lines for each part, with characteristic descriptions respectively, of the root, stem, leaf, inflorescence, and other distinctive features; it being supposed that the student will insert nothing but what he himself has observed. For his aid are also provided a synopsis of the terms most frequently used in the description of plants, a schedule of work to be performed in the botanical laboratory, and a list of subjects suitable for theses.

Signing the Document—The Laocoon of Labor—Chopping Sand—and other Essays. By Wheelbarrow. Chicago: "The Radical Review." Pp. 132.

The author of these essays assumes the name of "Wheelbarrow," he asserts, because he once labored with pick, shovel, and wheelbarrow on a railroad. He also states that he was once "clerk" to a brick-layer —that is, that he carried bricks for him. The series of essays was begun under prompting of the thoughts suggested by the telegraphers' strike of 1883; and most of them have grown out of other movements of working-men to better their condition. The burden of them is to expose the folly of the present management of those movements, and this is done in the most vigorous manner, whether it relates to trades-union despotism and exclusiveness, to the silver craze, or to any of the various tricks by which demagogues and monopolists, of whatever rank, seek to impose upon men who work—and all without hostility to any association for their real benefit. "In the present condition of society," says the author, "not to organize would be the very imbecility of resignation on the part of working-men. They may follow unwise principles for a time, but out of that organization a correct education will come at last."

Wonders and Curiosities of the Railway; or, Stories of the Locomotive in Every Land. By William Sloane Kennedy. Chicago: S. C. Griggs & Co. Pp. 254. Price, $1.25.

A pleasant book of history, gossip, and anecdote, about the origin and development of railways in Europe and America. The statements of fact are derived from authentic sources, and the anecdotical serves to give variety to the solid part. The volume is illustrated by cuts of various engines and cars, including the earliest made, that give graphic representations of the modest originals from which the present provisions for the accommodation of travelers have been worked out.

Lessons in Chemistry. By William H. Greene, M. D. Philadelphia: J. B. Lippincott & Co. Pp. 357. Price, $1.25.

The author of the "Lessons" is Professor of Chemistry in the Philadelphia High School. He has prepared them upon the theory that the object of a limited course in chemistry is not to make chemists of the pupils, but to teach them what the science is, what it has accomplished, and what it may accomplish; and that the study of the science can be made attractive only by arousing natural curiosity as to the cause of the

phenomena, while no greater mistake can be committed than to endeavor to make the facts dependent upon the theory. With brief explanations of principles, descriptions are given, in an attractive style, of the elements and their more considerable compounds, and of the more important chemical processes. "The Chemistry of Life" is explained in the last chapter; and notes on crystallography and hints for the preparation of experiments are given in an appendix.

The Laws of Health. By Joseph C. Hutchison, M. D. New York: Clark & Maynard. Pp. 223.

A manual of physiology and hygiene, including a discussion of the effects of stimulants and narcotics, for educational institutions and general readers. It aims to present as clear and concise an exposition of the subject as its elementary character will permit, and to introduce enough of anatomy and physiology to enable the pupil to study intelligently the laws by which health may be preserved and disease prevented. In an appendix are given practical directions for dealing with poisons and meeting emergencies, and for general sanitation.

Systematic Mineral Record. By Edward M. Shepard, A. M. New York: A. S. Barnes & Co. Pp. 26.

This manual consists of directions for determining the properties of minerals, with explanations of the terms by which they are denoted, and a form of schedule for recording observations. Lists of chemicals, apparatus, minerals, and books are given.

Report of the United States Commissioner of Fish and Fisheries for 1880. Pp. 1,106. Ditto for 1881. Pp. 1,217. Washington: Government Printing-Office. 1884.

The report for 1880 covers the tenth year of the work of the commission. Besides the commissioner's report, this volume contains papers on the plan of the work of the commission; deep-sea research, with illustrations of apparatus; the sea-fisheries; economic research; natural history, including a long and copiously illustrated paper on the sword-fishes, propagation of food-fishes, and about 350 pages on oyster-culture, also copiously illustrated. The volume for 1881 contains papers on the construction and work of the steamer Fish-Hawk, with figures of the steamer and its fittings; the mackerel, shad, and other fisheries; various biological researches; and the propagation of food-fishes.

Text-Book of Medical Jurisprudence and Toxicology. By John J. Reese, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 606. Price, $4.

This work has been prepared to meet the wants of students who desire something more convenient and manageable than the ponderous volumes in which the subject is more fully elaborated by the master-writers upon it. The author has endeavored to condense into a handy volume all of the essentials of the science, and to present the various topics in a simple and familiar style, giving larger prominence to those of the greatest practical importance. Special attention is given to the subject of toxicology, and fullness to the chapter on insanity.

Report of the Commissioner of Education for the Year 1882–'83. Washington: Government Printing-Office. Pp. 1165.

This report contains a vast amount of information in regard to the public schools and colleges of the United States, with some glances at foreign educational systems. The number of children in the country of school age, which in twenty-six States and Territories ended only with the twenty-first year, was 16,243,822; the enrollment in public schools was 10,013,826. The total expenditure for public schools reported was $91,158,039. The commissioner recommends an appropriation for the museum connected with the office, to enable it to collect and distribute the best illustrations of improved educational appliances; an appropriation for organizing an educational system in Alaska, which matter has since been attended to by Congress; and he renews recommendations as to the appointment of a Superintendent of Public Instruction for each Territory, and national aid to education from the public-lands money. The report contains a view and plans of the new building of the Harvard Medical School.

Report of the Commissioner of Agriculture for the Year 1883. Washington: Government Printing-Office. Pp. 496.

The commissioner continues the policy of establishing as intimate relations as possible between the department and the associations and institutions of the country which are devoted to the development and improvement of the art of agriculture, and of calling around it those whose knowledge and influence have given them especial authority; and he has perceived beneficial results from his course. Special subjects of investigation within the department have been the examination of microscopic fungi on plants, the chemical examination of cereals, experiments with sorghum, and the investigations in the entomological division on insects injurious to vegetation. The vegetation of the new and undeveloped parts of the country has been studied, especially the grasses, of which those that may promise to be useful for meadows and grazing purposes have been sought. An experiment station for the investigation of the contagious diseases of animals has been established near Washington, under the direction of Dr. D. E. Salmon. The full reports of these several departmental divisions, and of the investigations, are given in the volume.

Geological Survey of New Jersey. Annual Report of the State Geologist for 1883. By George H. Cook, New Brunswick. Pp. 188, with Plates.

Good progress was made, during the year covered by the report, in the topographic survey of the State, and the largest part of the work of the geodetic survey is done. Among the special topics of geological and economical interest discussed are the tertiary and cretaceous formations of the southern part of New Jersey, with accounts of the artesian wells at Ocean Grove and Asbury Park; the red sandstone and trap-rocks; the archæan rocks and iron-ore; the iron-mines; exploring for magnetic iron-ore, and locating mines; the progress of drainage and provisions for water supply at sea-side resorts and in large towns; and notes on native iron, copper, and zinc ores, graphite, plumbago, and black-lead, with statistics of mineral productions, manufactures from clay, bricks, and lime. A part of the matter is in continuation of previous reports; much of it covers new ground.

Our Birds in their Haunts. By Rev. J. Hibbert Langille, M. A. Boston: S. E. Cassino & Co. Pp. 618. Price, $3.

In the descriptions of the birds of Eastern North America, which make up this volume, the author has given especial attention to singing and nesting habits, and has dwelt upon whatever other characteristics were curious in each case. He has aimed to give either a full life-history, or at least a brief sketch, of every species commonly met with east of the Mississippi. The book is mainly a record of personal observation, supplemented by the notes of a correspondent in the Hudson Bay country; it contains many bright anecdotes of bird-life, and is written in a popular style, though giving the scientific name (following Dr. Coues) of each species, with the length of the bird and the dimensions of its egg.

The birds which may be seen in the same season in our Northern States are grouped together. The general reader will probably find most that is surprising in the records of their winter habits, and he will gather also from these accounts that Mr. Langille's love of nature is not torpid in cold weather. "The author addresses himself especially to men of his own profession—the gospel ministry; and would earnestly urge them to become, as far as possible, the interpreters of Nature as well as of the written Word." He has had in view, also, the popularizing of bird-study among farmers; the sportsman as well as the naturalist will recognize him as a fellow; and he has, in short, tried to make "a book on birds for everybody." Cuts of twenty-five species are given. Unfortunately, the errata do not include all the oversights in proof-reading.

The Wonders of Plant-Life under the Microscope. By Sophia Bledsoe Herrick. New York: G. P. Putnam's Sons. Pp. 248. Price, $1.50.

This elegant little volume is a beautifully illustrated and thoroughly popular presentation of some of the most interesting aspects of vegetable life. Mrs. Herrick is not only an enthusiast in her devotion to plant-studies and the microscopical

pursuit of botany, but she writes in a clear and attractive style, and makes her pages very instructive in relation to the later and most curious questions of vegetable economy. A considerable portion of her book was first published in a succession of articles in Scribner's "Monthly," but she has added new matter to the volume on fungi and lichens, orchids, mosses, and corn and its congeners. She allots considerable space to the insectivorous plants because of the fascinating interest of the subject, and because so little has hitherto been done to popularize the work of Mr. Darwin in this direction. Mrs. Herrick's volume well illustrates that the romance of fact is equally fascinating with the romance of fiction, and a good deal more real.

Magneto-Electric and Dynamo-Electric Machines. By Dr. H. Schellen. Translated from the third German edition by Nathaniel S. Keith and Percy Neymann, Ph.D. Vol. I. New York: D. Van Nostrand. Pp. 518.

In the third edition Dr. Schellen greatly enlarged his work, dividing it into two volumes, and gave it a more technical character than it had in the previous editions. The first volume treats only of apparatus for generating electric currents, and for measuring the currents and their effects. The descriptions of machines are preceded by a chapter on electrical principles, and one on electrical measurements. Successive chapters deal with magneto-electric machines, dynamo-electric machines, and machines for producing continuous currents. Some later alternating-current machines, for the production of several currents, are described, and the volume ends with a discussion of the conditions of efficiency in dynamo-electric machines. Large additions relating to American machines have been made by Mr. Keith. The volume contains three hundred and fifty-three illustrations.

Cassell and Company's Illustrated Holiday Catalogue. New York: Cassell & Co., Limited. Pp. 32.

The special feature of the publications of the house of Cassell & Co. is the prominence which is given in them to high art, combined with literary merit. The present catalogue comprises a list of fine-art and juvenile publications selected from the larger catalogues as most suitable for the holidays. It is adorned with illustrations of a very artistic character, many of them full-page, and is altogether a most attractive as well as, to the expectant buyer, a useful book.

A Migration Legend of the Creek Indians, with an Introduction by Albert S. Gatschet. Vol. I. Philadelphia: D. G. Brinton. Pp. 251.

This volume is Number IV of Dr. Brinton's "Aboriginal Literature." Mr. Gatschet's task is to present some results of ethnographic study of tribes who have lived in the territory just north of the Gulf of Mexico. Volume I now published contains accounts of the linguistic groups of the Gulf States, the Maskoki family, the Creek Indians, and the Kasi'hta migration legend, with text and translation.

PUBLICATIONS RECEIVED.

Feeding Experiments with Gluten-Meal. Massachusetts Experiment Station, Amherst; C. A. Goessmann, Director. Pp. 12.

The Duration of Color-Impressions on the Retina. By Edward L. Nichols, Ph. D. Pp. 10.

Onondaga Salt Springs. Annual Report of the Superintendent. Syracuse, N. Y. Pp. 39, with Charts.

Los Terrapleneros (The Mound-Builders). By José Manuel Mestre. Havana: Anthropological Society of Cuba. Pp. 30.

The Fucoids of the Cincinnati Group. By Joseph F. James, Cincinnati. Pp. 9, with Plates.

On Herderite. By F. A. Genth, Philadelphia. Pp. 6.

Report on the Phosphates of Alabama. By William C. Stubbs, State Chemist, State Department of Agriculture, Auburn, Ala. Pp. 33.

New York State Bar Association. Reports, Vol. VII. New York: Martin B. Brown, Printer. Pp. 255.

Genital Reflexes the Result of Phimosis. By T. Griswold Comstock, M. D., St. Louis. Pp. 26.

German simplified. Parts I, II, and III. By Augustin Knoflach. New York: A. Knoflach, Tribune Building. Pp. 48.

Aus Toscana (Out of Tuscany). By E. Reyer. Vienna: Carl Gerold's Sohn. Pp. 200, with Plates.

A Letter to Scientists and Inventors. By Lysander Spooner. Boston: Cupples, Upham & Co. Pp. 23.

Natural Law; or, The Science of Justice. Part I. By Lysander Spooner. Boston: A. Williams & Co. Pp. 21.

Sound-Signals. By Arnold B. Johnson. New York: D. Appleton & Co. Pp. 16.

On Oxygen as a Remedial Agent. By Samuel S. Walliam, M. D. New York: Trow's Printing Company. Pp. 52.

Jewish Hygiene and Diet. By Carl H. von Klein, Dayton, Ohio. Pp. 22.

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POPULAR MISCELLANY.

The International Prime Meridian Conference.—The International Conference, for fixing upon a prime meridian whence longitude should be reckoned, began its sessions in Washington, October 1st. Twenty-five nations were represented by forty delegates. Rear-Admiral C. R. P. Rogers, U. S. N., was chosen President of the Conference, and Lieutenant-General Strachey, of Great Britain, Mr. Janssen, of Meudon, France, and Dr. Cruls, of Rio Janeiro, were elected secretaries. A number of American scientific men and foreign visitors of scientific reputation, not regular delegates, were allowed to attend the meetings, with the understanding that they might participate in the discussions on special invitation. The first resolution adopted by the Conference declared the desirability of adopting a universal meridian. A resolution was then offered recommending the meridian of Greenwich as a standard meridian for longitudes, but it was withdrawn to allow the French delegates to introduce a resolution providing for a neutral meridian, which should cut no great continent. To this, it was objected that no suitable observatory was situated in any place which such a meridian would pass through; and that the selection of a meridian so situated would require a new set of observations and surveys to connect it with existing longitudes, and a readjustment of seventy-five per cent of all the world's charts, at an expense of about ten million dollars. The resolution for a neutral meridian was lost by a large majority. The resolution, "That the Conference proposes to the governments represented the adoption as a

standard meridian that passing through the center of the transit instrument at Greenwich," was then adopted, every state represented voting in favor of it except San Domingo, which dissented from it, and France and Brazil, which did not vote. The next resolution, recommending the counting of longitude in two directions from Greenwich, up to 180°, east longitude to be reckoned *plus*, and west longitude *minus*, was adopted by a small majority over the proposition to count continuously in a single direction to 360°. A fourth resolution proposed "the adoption of a universal day for the purposes for which it may be found convenient, and which shall not interfere with the use of local or other standard times where desirable." The fifth resolution recommends "That the universal day is to be a mean solar day, is to begin for all the world at the moment of mean midnight of the initial meridian coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours"; the sixth, "That the Conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight"; the seventh, "That this Conference expresses the hope that the technical studies to regulate and extend the application of the decimal system to the divisions of the circle and of time shall be resumed so as to permit the extension of this application to all cases where it presents real advantages."

Characteristics of North American Flora.—In a paper read in the British Association on the characteristic features of North American vegetation, Professor Asa Gray spoke of the resemblances and differences between the flora of North America and that of Europe, and their causes. The trees of the Atlantic border are similar to those of Europe. Many plants—among which are species of rhododendron, cypripedium, and coreopsis—may be found growing wild here, which are cultivated in the gardens of Europe. America is remarkable for its wealth of species of trees and shrubs. Besides the variety of leguminous trees and the wealth in species of *Compositæ* noticeable in America, there are many tropical plants which extend northward into the United States.

The Cotton Production of Alabama.—Some curious facts are brought out in Professor Eugene A. Smith's report on the "Cotton Production of Alabama." This State stands fourth in the United States in the total production of cotton, and also in the product per square mile (13·6 bales). The highest product per acre in the State is reached in Baldwin County in what is agriculturally styled the "long-leaved pine region," and the next highest in Cherokee County, in the "Coosa Valley region." In a larger sense, the highest rate of production is obtained in the central belt, having an area of less than seventy-five miles, which gives from seventeen to forty-three bales per square mile; the next highest, in the "Tennessee Valley region," which gives fifteen; and next, the Coosa Valley and the "oak, hickory, and long-leaved pine" regions, which give thirteen bales each to the square mile. The product of the State as a whole is equivalent to a little more than a bale for every two of its inhabitants. More than fifty-five per cent of the colored population of the State is found in the central cotton belt, where sixty per cent of the cotton is produced; and it is observed that so closely "does this class of the population follow the best lands, that the density of the colored population of any region might almost be taken as an index of the fertility of its soils," while the whites are much more evenly distributed over good and poor lands alike. This, however, is not strange, when we remember that the colored people were introduced as agricultural laborers, and put where they could be most advantageously employed. What should be the best cotton-lands begin to show signs of exhaustion through long and improvident cultivation. This is a logical result of the character of the laborers, who are unintelligent and not interested in keeping up the quality of the land, and of the inability or indisposition of owners to invest in improvements looking beyond the present year's crop. The general custom of depending upon advances of credit on the faith of the next year's crop has its influence in promoting deterioration of the soil. As cotton is the only crop which will always bring ready money, the planting of that staple is usually insisted on by the merchants making the advance, and it is also selected

by the farmer as the security to be offered. In this way it comes to be the paramount crop, and little chance is given for rotation with other crops.

Economy of Light.—In a paper before the American Association, on the "Economy of the Electric Light," Mr. A. Sterling stated that, for lighting a compact block, the incandescent light could be regarded as not more expensive than gas at $1.69 per thousand. Mr. Preece stated that the same quantity of gas gave more light when used to work an engine than could be got from it by burning it in the best gas-burners. Instances were given during the discussion where the amount of goods manufactured had been increased, or the quality of the goods improved, more than ten per cent, by the introduction of electric lighting. Mr. Preece explained the superiority of the electric light by showing that while in the arc-light a candle-power was obtained by the expenditure of one watt of energy, or in the incandescent light of two and a half watts, gas required the equivalent of sixty-two and candles of ninety-seven watts, for every candle-power produced. The most formidable obstacle to universal electric lighting was shown to be the great cost of the mains for conveying the electricity over long distances.

Velocities of the Krakatoa Air-Wave.—Professor Tacchini has found by examination of the Richard barograph that slight abrupt oscillations occurred in the barometric curves at Rome, on the 27th, 28th, and 29th of August, of last year, while the general daily record of the pressure was not essentially changed. Comparing the times at which these oscillations took place with the record of the times of the shocks at Krakatoa, he has deduced from them the conclusion that the wave of the shocks reached Rome from Krakatoa by the west, leaving the volcano at a velocity of 277 metres a second, while the wave moving in the opposite direction left it with a velocity of 296 metres. He further calculated that the complete atmospheric circuit round the globe was effected by the east, leaving Rome at a velocity of 295 metres, and of 318 metres for the wave going by the west.

The Wind as a Land-Carver.—A paper by General Prjevalski, on the structure of the plateaus of Central Asia, suggests enlarged views of the effects which atmospheric agencies have had in modifying the forms of mountains and valleys. Winds of excessive violence seem to have caused the fragments of stone to wear one upon another, and to have ground them up into pebbles, gravels, and sand; then to have carried the lighter parts of these materials to the valleys and deposited them there as a loess which has constantly grown thicker with succeeding years and centuries. M. Alluard has remarked upon an accumulation of wind-deposits that seems to have taken place on the Puy-de-Dôme. A temple of Mercury of considerable size formerly existed on the top of that mountain, but it has been covered up in the sand for nearly two thousand years; and, till some twenty or thirty years ago, none of the visitors to the place could have suspected that they were walking over such a structure.

Illusory Memories.—A curious question is presented by that experience of memory which nearly every person has probably had, in some form or degree, in which, when introduced to a scene or event really new, we have an impression, more or less distinct, of having met it before. Professor Henry L. Osborn, writing upon the phenomenon in "Science," suggests that it may arise from the dual structure of the brain, as the result of imperfectly correlated action in two images or impressions not absolutely simultaneous. The latter impression, being a repetition of the former one, gives rise to a feeling that it has passed through the mind at some indefinite previous time. Or, the false or illusory memory may have a real basis in some actual past representation which is identical or closely similar to the present one, or in some past images of the waking imagination, or dream-life. Plato conceived that these impressions gave support to the theory of a state of pre-existence in which identical experiences may have occurred. Mr. Sully suggests that the impression may be an inherited recollection of something that occurred to an ancestor. Lewes and Ribot ascribe the illusions to a false placing of a present mental image or

idea. Abercrombie tells a story of a lady who in extreme infancy was brought to her dying mother in a strange room to be taken leave of. Long afterward, having grown up with no recollection of her mother, she went into the room again, for the first time afterward, without the fact with which it was associated having been mentioned, when the whole scene of the leave-taking came back to her with force. Had not the connection of events been clearly traced, this instance would have been classed with the curious impressions we are considering.

Velocity of Pulse-Waves.—Continental physiologists have determined that the velocity of the pulse-wave is about twenty feet a second, and that the rapidity of its progress is essentially dependent upon the rigidity of the tubes through which it travels. Dr. A. T. Keyt, of Cincinnati, has supplemented their observations by experiments to determine the effect of other conditions in modifying the speed. He first set himself to determine the precise influence of tubes of different degrees of stiffness or elasticity on the velocity of the liquid waves sent along their interior, and selected for this purpose, first a glass tube, then India-rubber tubes of varying strength and firmness of pull, then tubes made of chicken-gut, and finally the aorta of a calf. The experiments demonstrated that the velocity of liquid waves in elastic tubes is proportional directly to the stiffness and inversely to the elasticity of the tube traversed; and they indicate the important modifying influence which the state of the arterial walls as to stiffness or elasticity must exert upon the rate of pulse-propagation in living arteries. In the series of tubes which he used, the velocity fell gradually from 216 feet per second in a tube of glass to 12·75 feet in a calf's aorta. In further experiments it was found that the rate of pulse-propagation is not affected directly by the manner of the heart's action, whether it beats quickly, launching a sharp wave, or slowly, sending a sloping wave; that, other things being equal, the pulse-wave travels more slowly along large, and faster along small, arteries; that mere distance from the heart neither accelerates nor retards the velocity of the beginnings of pulse-waves, while the modifying influence of different pressures is small at most; that liquid waves travel along elastic tubes at the same speed, whether the liquid be at rest or freely flowing; and that the consistence of the fluid makes no difference in the velocity of the wave.

The Earthquake of September 19th.—A light earthquake-shock was felt in West Virginia, Ohio, Indiana, and Michigan, on the 19th of September, between half-past two and three o'clock in the afternoon. The estimates of its duration vary from five to twenty seconds. No damage was done beyond the displacement of light articles, the throwing down of a chandelier in the insane asylum, and the jarring down of a freshly built arch, at Columbus, Ohio. In some places, schools, a Methodist conference, a woman's missionary society, etc., were temporarily dispersed by the panic. An observer at Indianapolis noticed that the tremor ran from east to west, and another counted seventeen distinct vibrations. At Lawrenceburg, Indiana, and at Toledo, Ohio, the indications were that the wave passed from southwest to northeast; at South Bend, Indiana, the motion appeared to be from north to south. At Wheeling, West Virginia, it was from northeast to southwest. A Signal-Service officer at Covington, Kentucky, who was reading the thermometer at the time, observed no agitation of the mercury. Boat-captains at Detroit say there was a noticeable rise in the river at the time of the shock. The earthquake was also felt at London, Ontario.

Hibernation of Snakes.—Mr. Arthur Stradling is investigating the hibernation of serpents, with particular attention to the greater sensitiveness to cold which they show in the spring than in the fall. He had under observation during last winter twenty-six snakes of different species. Some of them fed last in the latter days of September; and then they retired to the hibernating place provided for them at intervals one by one, the first one when the temperature had fallen to 41°, the last one on the 2d of December. Occasionally, some of them came out, under the temptation of warmth or light, when "it was most ex-

traordinary, according to one's preconceived ideas, to behold these creatures, some of them roaming about on the tree and gravel when the snow was lying on the ground outside, and the glass, which they were almost touching, was flaked with ice; even the pseudo-tropical specimens remained out until the temperature was much lower than that which seems to render our English species dormant. Though prepared for a well-marked difference in the temperatures of their retreat and reappearance, I had no idea that it would present so wide a range. Another curious anomaly was exhibited in the fact that daylight rather than warmth seemed to operate in drawing them forth; they all sought the box at dusk, although my reading-lamp raised the temperature of the room from 2° to 4° above that of the chilly morning, when they would issue from the aperture." Mr. Stradling believes that the difference in sensitiveness to cold manifested by his snakes at the seasons of retiring and waking is explainable on the same physiological principles as those which mark the condition of all animals in the fall and spring. In the fall, vital activity is at its highest; the animal has accumulated a coating of fat under its skin, and a store of combustible matter within to last it through the winter, and is able to endure much more cold than in the spring, when its vitality is weakened and its fat coat and surplus aliment are consumed.

Krakatau's Present Condition. — MM. Breon and Korthals, having just visited Krakatau and the region devastated by last year's eruption, have made a report upon the present condition of affairs there. The formerly flourishing city of Telok Betong no longer exists. The splendid vegetation of the Island of Seboukou has been destroyed by the joint action of the sea and the storm of hot cinders. The Island of Lebesia is completely covered with cinders and pumice. From the south, the Island of Krakatau presents the ordinary profile of volcanic cones. An appearance, when seen from a distance, as of clouds of vapor playing over the scarp, seems to indicate the existence of fumeroles; but on a nearer approach these clouds prove to be only masses of dust rising from land-slides which are continuously taking place. The travelers tried several times to approach the mountain from this side to obtain specimens, but were always repelled by a terrible bombardment of projectiles of every size. They succeeding in landing from the west, where there were no slides. Thence they were able to see distinctly, in the scarp, beds of rocks lying one upon another, separated only by small beds of siliceous tufa, as in all volcanic countries. The rocks apparently belong to the family of basalts, consisting of labradorites containing very little peridote. The recent eruption afforded products of a very different character, very acid pumices, seventy-two per cent of silica with plagioclase, bronzite, and magnetite. The former substance, which has, by emulsion with the gases, formed pumices, is a bottle-green glass, pieces of which may be found in the recent pumice-beds. Evidences were observed of a former acid eruption of the volcano.

Major Powell on American Languages. —Major Powell, in his paper at the British Association on the "Classification of American Languages," expressed the opinion that no other method of classifying the Indian tribes than by languages would be found satisfactory. The physical differences are certainly not sufficient. The arts are no criterion, as they are readily adopted by one race from another. Institutions are more permanent; but still in some cases they are adopted, and they do not sufficiently distinguish the races. Mythologies are more distinctive; and, indeed, it will generally be found that tribes speaking languages of one stock have similar mythological beliefs. There are in North America about eighty linguistic stocks, and as many mythologies. Major Powell proposed some important reforms, with a view to simplification and uniformity in the nomenclature of American languages.

Wampum.—In a paper read before the British Association on the "Nature and Origin of Wampum," Mr. H. Hale traced the use of that money across the continent to California; thence to the Micronesian groups in the North Pacific, where it is universal; and thence to China, where the money is said to have been anciently made of tortoise-

shell disks, or slips strung on cords. The common copper "cash" is made in imitation of this tortoise-shell currency, and is strung in a similar manner, and is used in ceremonial observances, like the American wampum. This form of money may originally have been introduced from China to the tribes of the western part of the continent, by means of shipwrecked junks. A discussion having risen as to whether wampum was a real currency or measure of value, Mr. Cushing stated that it had a definite value among the Zuñis. Dr. Tylor said that the shell-money is in use among the Melanesians, just as other currency is in the trade of civilized nations, and when lent is expected to be returned, with interest; the borrower of nine strings is expected to pay ten strings at the end of a month.

Homologies between North America and Europe.—Herr Valentine Ullrich has drawn a comparison of the morphologies of North America and Europe, for the purpose of showing that these two continents, though widely separated, exhibit, in their horizontal extension and the conditions dependent upon it, such points of agreement as can not be found in a similar degree between any other two parts of the world. He suggests that they may therefore be regarded as like two organic beings of the same species; as alike when regarded in the aggregate, and exhibiting the differences constituting individuality only in the details. North America should be considered as a sixth quarter of the globe, independent of the adjoining continent, the boundary-line from which is easier to draw than that separating Asia from Europe. The line is that marked by the Rio Chicapa or Chimalapa, flowing to the Gulf of Tehuantepec, and the Rio Quetzocoalcos, flowing to the Gulf of Campeachy, the sources of which rivers, only about four miles apart, are connected by the broad depression of the pass Portillo de Tarifa. It is recognized that the degree of civilization and intelligence which Europe has attained has been promoted by its situation between the seas, by its easy accessibility, by the extent of its river systems, by its numerous harbors, and by its freedom from impassable mountain-ranges. Similar conditions in North America tend to bring about a similar inevitable result; and this continent, not only on account of the energy of its inhabitants, but also on account of the advantages of its topographical features and climate, is destined to be the rival of Europe. Its surprisingly quick development in greatness and wealth is the result of no accident, but is the consequence of favoring natural conditions, without which even its most enterprising population would not have been able to accomplish so much. By reason of those conditions, the American States are promised an important future, and Europe is assured against decrepitude and decadence. Europe has strongly in its favor the broken shape of its land masses and the convenience of its seas, which serve as highways to the distant countries they reach in every direction. North America possesses similar advantages, but in a less marked degree. It is vastly more extensive than Europe; but Europe has relatively the larger coast-line, and is much better provided with harbors.

Against Over-pressure in Schools.—Commissions have been at work in several of the German states investigating the conditions of over-pressure in the schools, and official action has been taken on their reports to relieve the evil, for which physical exercise has been found not to be a sufficient counteractive. In Hesse, a limit has been fixed to the amount of home-study that may be imposed, and tests of progress that necessitate much reviewing have been forbidden. The Saxon Government has issued decrees against excessive attention to technicalities and the imposition of useless exercises in the classical departments, and particularly against the "*extemporalia*," or dictation exercises in the foreign languages, which, it is said, are calculated to produce in the student "a feeling of anxiety and vexation instead of an agreeable consciousness of knowledge." In Baden, the teaching-hours and the hours for home-study have been reduced, and the memorization of Latin words is disapproved of. The study-hours have also been reduced in Alsace-Lorraine, and six hours a week of physical exercise imposed. A petition, signed by teachers, physicians, and others, has been addressed to the Prussian Chamber of Dep-

uties, setting forth the mischievous effects of excessive strain upon the nervous system of scholars, and asking that an end be put to an abuse which "threatens, little by little, to reduce the cultivated classes of society to a state of moral weakness that shall render them incapable of great and manly resolution."

Effects of Tobacco on Youth.—Dr. G. Decaisne has made special observations of the effects of tobacco in thirty-eight youths, from nine to fifteen years old, who were addicted to smoking. With twenty-two of the boys there was a distinct disturbance of the circulation, with palpitation of the heart, deficiencies of digestion, sluggishness of the intellect, and a craving for alcoholic stimulants; in thirteen instances the pulse was intermittent. Analysis of the blood showed, in eight cases, a notable falling off in the normal number of red corpuscles. Twelve boys suffered frequently from bleeding of the nose. Ten complained of agitated sleep and constant nightmare. Four boys had ulcerated mouths, and one of them contracted consumption, the effect, Dr. Decaisne believed, of the great deterioration of the blood, produced by the prolonged and excessive use of tobacco. The younger children showed the more marked symptoms, and the better-fed children were those that suffered least. Eleven of the boys had smoked for six months; eight, for one year; and sixteen, for more than two years. Out of eleven boys who were induced to cease smoking, six were completely restored to normal health after six months, while the others continued to suffer slightly for a year.

Danger from Overhead Wires.—Professor Sylvanus P. Thompson mentions as one of the most solid objections to overhead wires, that they are a permanent and absolute source of danger, because every wire of whatever kind deteriorates more or less slowly under atmospheric influences, especially in the smoky, sulphur-laden air of cities. Those best qualified from long experience to speak on the subject agree that the life of every wire is limited, and no one can tell how or when it will snap. The fact has been established by Professor Hughes that every vibration imparted to a wire brings it a stage nearer to a state of internal crystallization, when, its fibrous structure having become completely degenerated, it snaps short. He has measured the number of vibrations which determine the length of life of wires of different kinds, and finds it to be varying according to the material, but limited in every case. "Given at first a wire of ideal perfection, when it has swayed to and fro its allotted number of hundreds of thousands of times in the breezes, it must snap. But no such wire is attainable; all are more or less faulty, and can not be relied on, even with the most diligent inspection, when once set up in the smoky air." Numerous accidents, according to Mr. Preece, have arisen from the falling of wires, and a case is on record where an omnibus-driver was decapitated from such a cause.

Atmospheric Action on Sandstone.—M. E. Wadsworth, of Cambridge, records certain observations on St. Peter's and Potsdam sandstones, made several years ago near Mazomanie, Wisconsin. The St. Peter's sandstone is composed almost wholly of a pure quartz sand, and in the outliers of it, found on the hill-tops south of the town, the parts covered by the soil were more or less friable, and the grains distinct; while the exposed portions of the same blocks and slabs were greatly indurated, the grains being almost obliterated, and the rock possessed the conchoidal fracture and other characteristics of a quartzite. In the autumn of 1872 a block of clear white Potsdam sandstone was found, the protected side of which was friable, while the other sides, especially the one most exposed to the prevailing storms, was nearly a quartzite. This block was only about two feet square, and, as a test of the correctness of the above conclusion, the indurated surface was broken off, and a comparatively friable surface exposed. This locality was visited the following spring, when the fresh surface was found much indurated, and approached toward a quartzite.

Phosphoric Glass and its Applications.—At a recent meeting of the French Academy of Sciences, a number of articles were presented for inspection that were made of a glass composed simply of phosphate of lime. The new application is the invention

of M. Sidot, who has been carrying on successful experiments with it since 1877, and has made most excellent tubes, bottles, and retorts, of "phosphoric glass." Vessels of this substance are particularly useful in manipulating the fluorides, for phosphate of lime is not acted upon by fluorine. M. Henri de Parville foresees an interesting use to be made of phosphoric glass in connection with cremation. The ordinary part of that process having been completed, our ashes, instead of being deposited in a vase, will be reduced to phosphate of lime; this substance then converted into phosphoric glass; and the glass molded into a vase, a medallion, or a memorial statuette of the person from whom it has been derived.

Advantages of Woolen Underclothing.—The advantages of woolen underclothing, besides its warmth, and the closeness of its application, depend upon its better adaptation in respect of temperature to the requirements of climates and to changes of season than any other material for dress. It also has a special faculty for absorbing and distributing moisture that makes it particularly salutary next to a perspiring skin. A linen garment will absorb the products of transudation till it is wet and becomes sticky upon a moist and clammy skin, while flannel will rest upon a skin which it has nearly dried, and be only damp itself. Hence, the body wearing flannel is in the best condition to resist the after-chills that follow great perspiration. The irritation caused by flannel, which is brought up as an objection against it, is an accompaniment only of new flannels and coarse ones, and is generally a merely transient condition.

Patagonian Geology, and a Former Southern Continent.—Señor F. P. Moreno has communicated to the Argentine Scientific Society the results of geological explorations which he has made in Patagonia, beginning in 1876. In the ascent of the Santa Cruz, at five degrees above where Darwin had given up a further exploration of that river, he came upon a country roughly cut up by cañons, and presenting most of the peculiar features of our "Bad Lands." About halfway between the mouth of this river and the Andes, he discovered a region "forming the base of a high terrace, surmounted by high peaks that gave it the aspect of a half-ruined Gothic cathedral, exceedingly rich in tertiary mammalia. In the upper part of this formation, which was about two hundred and fifty metres high and one hundred and fifty metres broad, were discovered, beneath the superficial layers of glacial *détritus*, several alternating lacustrine and marine beds indicating successive immersions and emersions. In them the three divisions of the Tertiary period were represented by very distinct mammalian fossils corresponding with ancient forms of marsupials, pachyderms, edentates, rodents, and carnivores. Perhaps one of the most curious features of these fossils was the number of transitional forms among them; an animal combining features of the marsupials, the land carnivores, and the pinnipeds, in such a way "that, if the remains did not exist and we should describe an animal possessing all their characteristics, we should be thought to be imagining some fabulous monster"; animals of an order intermediate between the ungulates and the rodents; and a molar, "which can be attributed only to a gigantic *cabiai*, or a dwarf elephant." This fauna is more ancient than the Argentine mammalian fauna, and is probably quite as comprehensive. The discoveries have thrown a new light on the geological history of South America; for Patagonia was formerly regarded as of marine origin, but they prove much of it to have been terrestrial and lacustrine. They also lend some weight to the opinion expressed by Señor Moreno that, at the beginning of the Tertiary period, a vast continent, of which Patagonia was a part, extended east and west. The rich fauna and the luxuriant vegetation, evidences of which are also found, could not have come down from regions nearer the equator, as has been supposed, that is, from more favorable to less favorable conditions, but must have originated in this region, and pushed up toward the tropic under the influence of the growing cold that came upon the country. The southern part of the continent still shows signs of oscillation. An elevation of one hundred and fifty metres would consolidate the land with Tierra del Fuego and the Falkland Islands into a continent as wide as Africa at the Orange River

An elevation of less than two thousand metres would unite this land with South Georgia, South Sandwich Land, and the Antarctic Continent. The chain of the Andes has not the same continuity in these regions as in the north of the continent. The labyrinth of islands and channels constituting the Straits of Magellan and Le Maire is only a continuation of the isolated moraines and cañons, now dry, which so singularly break up the ground of Patagonia. The presence of marsupials and the seventy-seven common species of plants likewise point to the possibility of a former nearer relation to Australia and New Zealand than now exists.

Wine-Statistics of the World. — The greatest wine-producing country of the earth is France, which also furnishes the greatest variety and the most-sought-for wines. The total production of the country has fluctuated greatly in late years, on account of the ravages of the phylloxera. It was nearly 2,246,000,000 gallons, wine measure, in 1875, and less than 689,000,000 gallons in 1879. The average is estimated at 1,456,000,000 gallons. The vine is cultivated in all but nine of the eighty-six departments, but most extensively in the southern departments, that of Hérault leading the list. Italy ranks the second among the wine-lands, with an average production about half that of France, or of 715,000,000 gallons, the total value of which is estimated at a milliard of lire. The export trade is growing fast and has become very large. Spain follows as the third greatest wine-producing state, with 583,000,000 gallons. The southern wines are in greatest demand, and the export trade is assuming enormous dimensions. Next in order is Austria-Hungary, with 371,000,000 gallons, a large part, and the choicest, of which is produced in Hungary. Portugal is fifth among European wine-lands, with 132,000,000 gallons, among which are the famous port wines, forming the basis of a large export trade. Germany, with only a small part of its land in cultivation for wine, and an annual return of 95,400,000 gallons, does not produce as much as it consumes, but imports from France and Austria-Hungary. Russia produces 53,000,000 gallons, chiefly in the southern provinces, or those bordering on the Black and Caspian Seas. Of the smaller states, Greece produces about 39,750,000 gallons; Switzerland, 36,320,000; European Turkey, 26,000,500; Roumania, 31,800,000; and Servia, 13,250,000. Belgium makes the smallest showing of all the European states that produce any wine. The total production of the fourteen states enumerated is estimated at 3,577,500 gallons a year. Wine is also a very important staple of Asiatic agriculture, and forms a notable item in the crops of all of Asiatic Turkey, Palestine, Arabia, Persia, Afghanistan, Bokhara, and parts of India, while in Cochin-China, China, and Japan, it is of relatively small account. In Africa it is a considerable item in Algeria and the Cape Colony, and is made in only mentionable quantities in Egypt, Abyssinia, Morocco, the Orange Free State, and the Transvaal. The wine-culture of the Canary Islands and the Azores has recently suffered greatly from diseases of the vines. The United States produced 23,453,000 gallons of wine in 1880, and it was worth $16,000,000. More than a quarter in value of the product came from California. Wine is produced in a primitive way in Mexico, Brazil, the Argentine Republic, and Chili. The wine industry has been developed to a considerable importance in Australia, and promises to grow.

Science and Industrial Development.— One of the demands of the times, according to "Nature," is for the co-operation of scientific investigation in the study of new principles with artisan skill, in immediately applying the new discoveries to practical uses. As among the fields in which such a combination might prove itself valuable, it is suggested: "There is great need of some system of light railways which can be laid down on ordinary roads, and so cheaply that the traffic available on such roads may be sufficient to pay a fair return on the capital. . . . The storage of power, such as that of the tidal-wave, with cheap and ready means for giving it out when and where it is needed, offers a wide field for invention, and may lead to the most fruitful results. The transmission of power to long distances, whether by electricity, compressed air, or otherwise, is a somewhat similar problem, which at present occupies the attention of many en-

gineers and men of science. Lastly, the more homely subject of house-building offers at this moment special inducements to constructive genius." "Nature" fears, however, that the prominent part in speeding progress in this line of invention is destined to fall to other countries than England. The latest and most important movements in the direction of cheapened transportation and the storage and transmission of power have been made in France, Germany, and America, while, in respect to scientific architecture, "England stands far nearer the bottom than the top in the scale of civilized nations." This is because "in America, in France, above all in Germany, the union between science and art is far more close and cordial than with us. Every practical constructor or manufacturer is anxious to know all he can of science; every scientific professor desires to mix practice with his theory. Thus, on the one hand, we find ordinary engineers drawing on all the resources of mathematics for the solution of such problems as the proper section of rails or the resistance of trains; on the other hand, we see Clausius, perhaps the greatest of German physicists, devoting two long papers to investigate the working theory of the dynamo-machine."

Antiquity of Fossil Human Skeletons.— Mr. T. V. Holmes, of the Essex Field Club, England, discussing the recent "find" of a human skeleton in the alluvial clays of Tilbury, showed that the skeleton was comparatively recent, though undoubtedly prehistoric, and added that geological position furnishes the only absolute test of relative age. The test of association with extinct mammalia is largely dependent on negative evidence. A hint on this point was given by the results of the drainage of Haarlem Lake thirty years ago. Excellent sections were made in all directions across its bed, and carefully examined by skilled geologists. Hundreds of men were known to have perished in its waters three centuries before, and it had always been the center of a considerable population. Yet no human bones were found, though works of art were discovered. Thus hundreds, or even thousands of mammalia, incapable of producing works of art, might be interred in particular strata, and yet leave no signs whatever of their former existence two or three centuries afterward. And, on the other hand, were extinct mammalia present in the Tilbury Dock beds, no additional antiquity would thereby be conferred on the beds themselves, but the period at which the animals became extinct would be shown to be later than had been supposed. Similarly, as regards the rude implements known as palæolithic, their presence could confer no antiquity on recent beds.

Gathering Edible Birds'-Nests. — The material from which the famous Chinese bird's-nest soup is made can be obtained in quantities at only one place in the world, and this spot has been visited recently by Mr. Pryer, a naturalist of Yokohama, Japan. It is at Gomanton, some thirty miles up the Sapugaya River, in British North Borneo, in two caves, called by the natives the Black and the White Caves, which are situated in a limestone cliff 900 feet in height. The Black Cave is 100 feet wide, by 250 feet high at the eaves, with a roof rising to 360 feet high in the middle. The interior is well lighted by holes in the roof, and is filled with clusters of the nests of bats and swifts. The White Cave is 400 feet higher up. Mr. Pryer discovered the material from which the nests are made in the shape of a soft, fungoid growth that incrusts the limestone in all damp situations, where it attains the thickness of about an inch, and is dark brown on the outside and white in the inside. The birds make the black nests from the outside layer, and the white nests, which are best esteemed, from the inside. The "moss" is taken by the bird in its mouth and drawn out in a filament backward and forward, like a caterpillar weaving its cocoon. A wonderful sight is witnessed at night, when the bats fly out of the caves in a score of flocks of many thousands each, with a rushing noise, and the birds come in in a similar style, and in the morning when the birds go out and the bats come in. Near the center of the largest cave, the explorer was shown a small beam of light from a funnel at the top of the rock, exactly 696 feet above his head. The nests are gathered from these enormous elevations by means of pendent, flexible rattan ladders and stages.

On these two men take their station; one carries a light, four-pronged spear about fifteen feet long, just before the prongs of which a lighted candle is fixed. Holding on with one hand, he manages the spear with the other hand, transfixes the nest, and detaches it from the rock. He then pushes the spear toward the second man, who takes the nest off the prongs and puts it in his "game-bag." The annual crop is estimated to be worth from $25,000 to $30,000, local value, and much more in China. The caves have been worked for seven generations, without any apparent diminution in the product, although three crops are gathered in the year. The floors of the caves are covered with a deposit of guano of unknown but great thickness.

NOTES.

Correction. — The paper on "School Culture of the Observing Faculties," in the December "Monthly," was written by Mr. J. C. Glashan of Ottawa, Canada, and not Glashaw, as printed.

M. G. Chauvet, in a monograph on the prehistoric polishing tools of Charente, France, notices the fact that flints very like some of the stone-age hatchets were, till recently, used in the factories of Angoulême for polishing playing-cards. The polishers are now made of copper.

A number of the members and officers of the Academy of Natural Sciences of Philadelphia have associated themselves into a Bureau of Scientific Information, the object of which is to impart, through correspondence, precise and definite information bearing upon the different branches. The bureau consists so far of twenty members, each of whom volunteers his services in his particular field of investigation. Professor Angelo Heilprin is secretary of the association.

Certain mushroom universities in the West and South seem anxious to put a high-sounding degree of some sort "within the reach of all." The allurements of these institutions include, in the department of letters, the degrees M. E. L. (Master or Mistress of English Literature); M. L. A. (Mistress of Liberal Arts); L. E. L. (Laureate of English Literature); L. A. (Laureate in Arts); B. E. (Bachelor of English); M. P. L. (Mistress of Polite Literature); and M. L. (Master of Letters); in science, A. C. (Analytical Chemist), and B. S. (Bachelor of Surgery); and in other departments are offered M. P. (Master of Philosophy); B. P. (Bachelor of Painting); M. A. (Master of Accounts); and L. I. (Licentiate of Instruction). One institution gives the degrees B. P. (Bachelor in Pedagogics); P. P. (Principal of Pedagogics); T. E. (Topographical Engineer); S. (Surveyor); and B. D. A. (Bachelor of Domestic Art). A person acquainted only with the effete colleges of the East would be at a loss on what scale to estimate the attainments of those who had been graduated with these degrees.

Sir H. E. Roscoe, speaking in the British Association of the diamantiferous deposits of South Africa, and the ash of the diamond, showed that silica and iron oxide form constant constituents of the diamond. He also stated that, when these yellow diamonds are heated out of contact with the air, they lose their color, and remain colorless so long as they are not exposed to the light; they then regain their color.

Mr. F. W. Putnam described before the American Association the exploration of the "Turner" group of mounds near Madisonville, Ohio, which had been conducted in the most careful and thorough manner, with examination of the earth shovelful by shovelful. The discoveries, both of objects obtained, and of facts regarding the structure of the mounds, were exceedingly valuable. Among the objects, some of which had never been found before in mounds, were shell-beads, disks, and rings by the thousand; cones cut from alligator-teeth; ornaments from buffalo-horn, mica, and copper; objects of native silver, gold, and meteoric iron; 50,000 pearls, mostly pierced and injured by heat; small stone dishes carved in animal forms; and artistically shaped figurines of terra-cotta, suggesting an Egyptian character.

Nordenskjöld is understood to be preparing a new three years' expedition under Russian auspices, the object of which is the north pole. He will start first for the newly discovered Bennett Islands, Henrietta and Jeannette, in the New Siberian Archipelago, where deposits of provisions will be made; thence to Franz-Josef Land, where other provisions will be left, and whence a start will be made in three divisions, for the pole.

The meeting of German naturalists, which opened at Magdeburg on the 18th of September, under the presidency of Dr. Gaehde, was attended by more than a thousand men of science. Among the addresses delivered was one on the relation of micro-organisms to the infectious diseases of man, by Professor Rosenbach, of Göttingen. Dr. Gerhard Rohlfs spoke on the importance of German colonization in Africa.

In the Biological Section of the American Association, Dr. G. M. Sternberg described his experimental research relating to the etiology of tuberculosis. He had repeated the inoculation experiments of Koch, with similar results. The experiments of Formad to induce tuberculosis in rabbits, by introducing into the abdomen finely powdered inorganic material, had been repeated, with entirely negative results. Dr. Sternberg held that Koch's bacillus was an essential factor in the etiology of tuberculosis.

Sunlight or starlight in passing through our atmosphere loses by absorption an amount which is commonly rated at twenty per cent of the whole. By experiments made both near the sea-level and at altitudes of nearly 15,000 feet, Professor S. P. Langley has been brought to the conclusion that the previous determinations are largely in error. He believes it probable that the mean absorption of light (and of heat also) by the atmosphere is at least double that which is customarily estimated, and that fine dust-particles play a more important part in this absorption than has been heretofore supposed.

Professor Landolt recently exhibited before the Academy of Berlin a cylinder of solidified carbonic acid which had been kept for more than an hour in that condition. He had prepared it by passing liquid carbonic acid from a compressor into a conical sack of canvas, in which it assumed the form of melting snow, and then ramming the whole into a cylindrical vessel.

Signor Michela, of Italy, has devised a kind of telegraphic short-hand which he calls steno-telegraphy. It consists of a machine by which signs corresponding to various sounds can be telegraphed, and by means of which, it is claimed, 10,000 words can be sent in an hour. It has been used for some time in telegraphing the debates of the Italian Senate.

M. E. P. N. Fournier, a French botanist whose death was recently announced, edited in connection with M. Egger the work of Theophrastus on plants, and was preparing a flora of Mexico for the French Government and a flora of Brazil for the Emperor Dom Pedro.

Senhor Ladislao Netto, of Rio Janeiro, in a lecture on evolution at Buenos Ayres, gave some remarkable illustrations, from his own observations, of the power of plants to adapt themselves to diverse conditions. The same plants which became enormous vines in the dense Brazilian forests may be found growing as ordinary shrubs in the open. He and M. Lacerda have found the *Strychnos triplinervia* in isolated situations as a bush a little over six feet high, with no signs of a climbing tendency except a few atrophied tendrils; while in a wood only a few steps away another individual of the same species had a slender stem, with internodes, sixty feet in length; and the plant frequently grows to be seventy-five feet long. Other plants are mentioned by Senhor Netto, particularly the *Thorinia scandens*, which after having become quite respectable vines, began to increase irregularly in thickness immediately on having the sunlight let in upon them.

Observations made by Dr. L. Glaser, of Mannheim, in the river-valleys of Germany during the wet seasons of 1882–'83 and 1861–'62 have led him to the conclusion that heavy winter rains and floods are very destructive to insect-life, and have a marked effect in diminishing the "bug-crop" of the following season.

Recent observations of the British Meteorological Office on the temperature of the Gulf Stream between the latitudes of the north of Ireland and Bordeaux, and extending half-way across the Atlantic, go to show that the temperature of the water was abnormally high (1° to 3° above the mean) during June, July, and August.

OBITUARY NOTES.

Among the deaths of last summer was that of Count Constantin Branicki, an earnest promoter of natural science, who had made valuable contributions to the Museum of Warsaw, Poland.

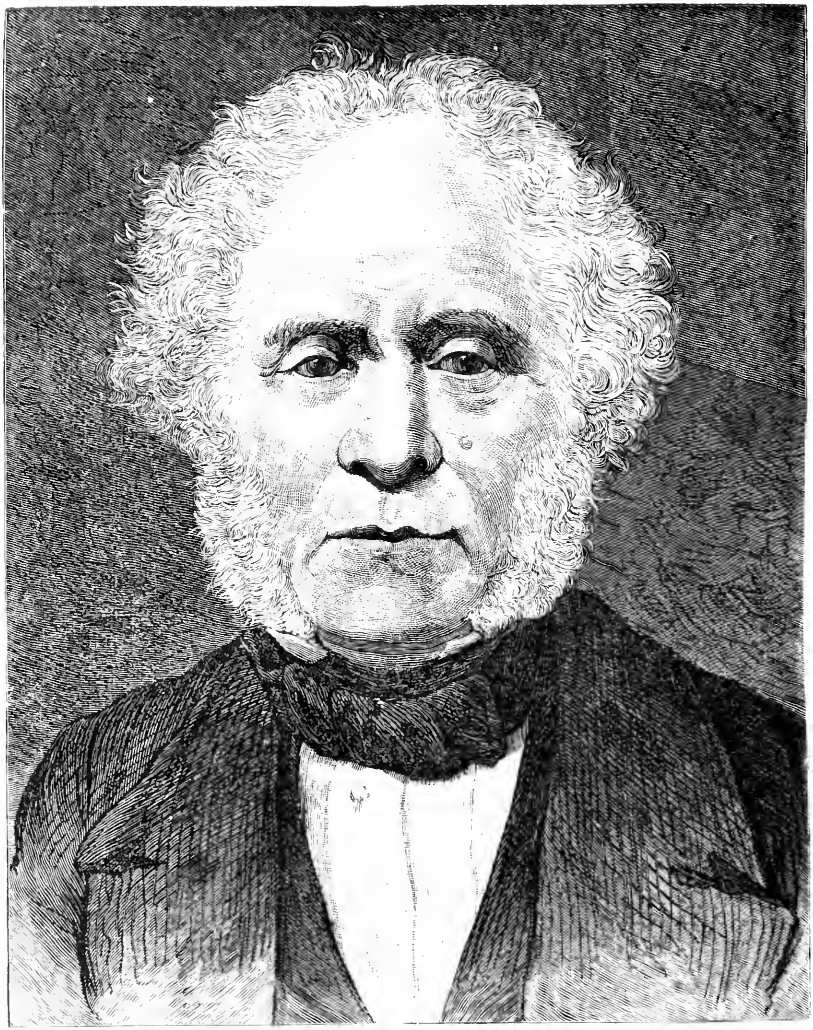
Professor Bros Emil Hildebrand, one of the most distinguished of European antiquaries, died at Stockholm, on the 30th of August last. He was Royal Antiquary of Sweden, and under his care the Swedish archæological collections became among the richest and most curious in Europe.

Julius Cohnheim, a German pathologist, is dead, in his forty-fifth year. He was a pupil of Virchow's, and filled professorships at Kiel, Breslau, and Leipsic.

Among the active students of botany who died last year are E. P. M. Fournier, at Paris, and Ludovico Caldesi, at Faenza, Italy.

G. B. Delponte, formerly Professor of Botany in the University of Turin, died some months ago at Mombarrizzo, Piedmont. He was well known for his researches on the *Desmidiæ*.

Chemistry has lost by death, during the past year, Dr. Carstanjen, of Leipsic, who was fifty-nine years old, and Dr. Hans Hübner, director of the chemical laboratory at Göttingen, who was in his forty-seventh year.



SIR DAVID BREWSTER.

THE

POPULAR SCIENCE MONTHLY.

FEBRUARY, 1885.

THE SIGHT AND HEARING OF RAILWAY EMPLOYÉS.*

BY WILLIAM THOMSON, M. D.,

PROFESSOR OF OPHTHALMOLOGY, JEFFERSON MEDICAL COLLEGE.

SHORTLY after the demonstrations of Professor Holmgren, in Sweden, of the dangers in transportation to persons and property on land and sea from color-blindness, the writer called the attention of the officers of the Pennsylvania Railroad to the subject; and, at the request of the president, Mr. Thomas A. Scott, and the vice-president, Mr. Frank Thomson, he undertook to solve the problem of eliminating these dangerous men from their service. To his first statement that there were probably four per cent of men incapable of distinguishing unerringly between red and green flags by day, or lights by night, it was responded that their signals alone would detect such men, and force them from their places, since, as we all know, the most imperative orders in railway administration are transmitted through the visual organs, in the white of "Safety," the green of "Caution," and the red of "Danger"; and it was considered by the officers of the road impossible for men color-blind to pass the thousands of signals in daily use on their thousands of miles of road without detection. A very slight search dispelled this idea, and a demonstration of the defect before the Society of Transportation Officers of the Pennsylvania Railway aroused the members of it to the dangers to be feared, and led to the appointment of a special committee to aid the writer in completing a system which would have practical value, with the Gen-

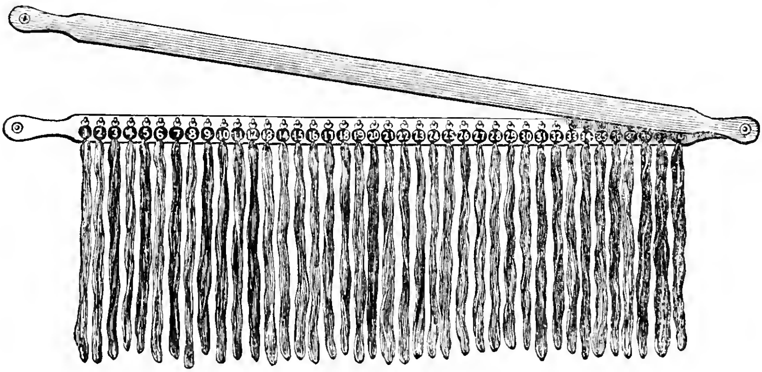
* Read before Section B of the American Association for the Advancement of Science, at Philadelphia, September 8, 1884.

eral Manager, Mr. Pugh, as its chairman, to whose keen interest much of its success is now due.

The magnitude of the task then began to appear, when the forty or fifty thousand employés of five thousand miles of track, with their ten or twelve thousand men actually dependent upon signals of color for their guidance, of whom four per cent might be color-blind, and ten per cent so defective in visual power, for form and hearing, as to render them dangerous, arose before the imagination. To have adopted the method of Holmgren for the color-sense, by which an accomplished ophthalmic surgeon would conduct the examination of each man, would have demanded years of his entire time, would have been so tardy as to allow large additions to the force before it could be accomplished, and was soon rejected as impracticable; neither was it thought possible to train a sufficient number of the company's surgeons to perform this special task with fairness to the men and safety to the company. To secure the co-operation of the employés the officers needed a system that could be applied locally on each division, quietly and confidentially, and at the convenience of the men, without compelling them to lose much time. Any undue publicity, or inexorable law that would compel the summary discharge of from ten to fifteen per cent of their trained operatives, would have disorganized the service, and destroyed the discipline of the company; and for their own protection, and as a duty to the public, the officers were willing to put on trial any practicable scheme, without the pressure of any over-anxious public opinion or hostile legislation.

These, and other considerations of weight, led the writer to the invention of an instrument for the examination of the color-sense, which could be efficiently used by any intelligent, instructed official, and a record of it permanently kept for the information of the officers, and as a guide for the action of any surgical expert whom the road might appoint to superintend the entire system. This consists of forty skeins of wool, each one attached to a movable button, having figures from 1 to 40 inscribed on them, suspended from two flat sticks, so arranged that the numbers are concealed. Holmgren's method of matching colors is adhered to, and the test-colors to be matched are green, rose, and red: the skeins from 1 to 20 being used for green, those from 21 to 30 for rose, and from 31 to 40 for red; upon the *odd* numbers are suspended green, rose, and red skeins; upon the *even* ones those "confusion colors" which the experience of the writer had taught him would be the most likely to be selected by the color-blind. In its use a green skein is placed before the person at a few feet distant, and he is directed to select those of that color from the stick, and to turn them away or throw them over; then the rose, then the red; and as this is done for each test-skein, the numbers upon the buttons are inspected and recorded upon a blank. So simple is this system that the division superintendent, who is responsible for the examination, may forget

all its details if he but remember that upon the blanks submitted to him for his action must appear only *odd* numbers, and that if the *even* ones are mingled the case is one of color-blindness.



DR. THOMSON'S COLOR-TEST.

For the acuteness of vision the best and most simple method is to employ letters of known size at given distances; and, as we might meet with men who could avail themselves of opportunities to learn by heart those of "Snellen," ordinarily used, the writer had a rotary disk constructed on the same principle, whereby but a few letters were exposed to view, but many more could at will be brought into sight when desired. For the hearing, a watch and the voice in conversation were used.

These instruments, together with the Rules and Regulations now submitted to you, won the approval of the committee of railroad officers, were put into practical use in two thousand preliminary examinations, were adopted by the highest officers, accepted by the Board of Directors, and ordered to be put in force upon the entire road, under the supervision of the writer as their surgical expert. His duties were to assure himself of the accuracy of all instruments, to give instructions to the examiners of the different divisions in their use, to give his opinion upon any doubtful cases, their blanks being placed before him, and to examine personally any men sent for the purpose, and to render fit for service, by medical or surgical treatment, or by proper correcting glasses, any capable of such relief.

From an inspection of the blanks, and a knowledge of the men, the Division Superintendent could deal with most of the cases by suspending or transferring them to other duties. The blanks of the color-blind, and those much below the standard of vision, were transmitted to the surgical expert, and, upon his advice, the men could be sent to his office, where the color-blind were re-examined by the "stick" by Holmgren's method, by that of Stilling, advised by the last International Congress, and by Donders's instrument, by which the lights of the lamps and signals at night are so perfectly imitated in color, size,

WEST JERSEY RAILROAD COMPANY.

CAMDEN, *January 19, 1883.*

EXAMINATION OF SIGHT AND HEARING OF

James A. Morris, aged twenty-two, employed as Locomotive Fireman, Applicant for ——.

ACUTENESS OF VISION. The number of the series seen at twenty feet distant.		RANGE OF VISION. Least number of inches at which type D—0,5. in test-type pamphlet can be read.	Right eye, 4½ inches.	Left eye, 4½ inches.
Right eye....	20–30	FIELD OF VISION.		
Left eye.....	20–30	Good or defective..................	Good.	

Color-Sense.

Test-skein submitted	Name given.	NUMBERS SELECTED TO MATCH.
A—Green..........	Green.	3, 26, 24, 7, 11, 22, 15, 5, 1, 17, 28, 9, 19, 30, 13.
B—Rose...........	Red.	37, 33, 29, 12, 39, 31, 21, 35, 25, 27, 23.
C—Red............	Red.	37, 33, 31, 35, 23.

SECOND COLOR-TEST.			THIRD COLOR-TEST.		
Number shown.	Name given.	Numbers selected.	Flag shown.	Name and use given.	Numbers selected.
24	Green.	26, 22.	Soiled White.	Safety, White.	2, 4, 6.
39	Yellow red.	Could find no match.	Soiled Green.	Caution, Green.	36, 38.
30	Blue.	26.	Soiled Red.	Danger, Red.	37, 33, 31.

Selection prompt or hesitating:

Prompt.

Hearing.

RIGHT EAR.		LEFT EAR.	
WATCH.	CONVERSATION.	WATCH.	CONVERSATION.
8 feet.	20 feet.	8 feet.	20 feet.

Remarks:

Escaping steam prevented watch-test.

J. J. BURLEIGH, *Examiner.*

Acuteness, right eye defective. Range, good. Field, good. Color-sense, defective. Hearing, see Remarks. JOS. CRAWFORD, *Superintendent.*

NOTE.—Those approved marked "Appd."
Those not approved marked "Not appd."

Fac-simile of one of the blanks.

and intensity, and the degree of color-defect measured by means of the ratios that exist between the sizes of the openings transmitting the colored light and the distances at which the man may be placed; the small opening which should be seen by the normal eye at five metres distant, is in diameter one millimetre, while the largest, twenty millimetres, when used at five metres, if not recognized, shows $\frac{1}{20}$ of color-

sense, or at one metre shows $\frac{1}{100}$, or at one third of a metre or one foot shows but $\frac{1}{300}$ of color-sense, where many fail to distinguish the color even at this short distance: finally, by coarse tests of colored glasses placed in front of large gas-lights, and by flags shown near at hand. No color-blind man has lost his place without the satisfaction of a professional examination, and a full demonstration of his defects in most instances even to his own satisfaction. Should he fail to see the red, for example, at five metres, of the large opening in Donders's instrument, or of a gas-light with a red glass before it, calling it green, he would be directed to obey the green signal and approach it slowly, walking up to it until when within one metre or less he might perhaps recognize it as the danger-signal, when too near to prevent an accident. Color-blindness, it must be remembered, is in some respects like deafness, and with its various degrees there are different possibilities of disaster.

No excitement has arisen, no interference with the business of the road, no color-blind man has escaped detection, very few mistakes have been made by the examiners, not a single word has been changed in the instructions, and there is nothing now to amend, except perhaps to make the color-stick into a smaller, more elegant, and self-registering instrument.

One simple test not hitherto mentioned has been used in the first moment of the writer's examinations, by placing a piece of cobalt-blue glass in front of the man's eye, and directing him to look at a gas-light of moderate size like a candle, at twenty feet distance; this glass transmits both blue and crimson light, and the normal eye sees a rose-colored flame surrounded by a blue halo, while the color-blind sees no red, but describes it as composed of two shades of blue only.

That the color-blind depend upon the relative intensity of the lights to distinguish them is shown by the fact that, if over a white light we place a medium shade of London-smoke glass, it will probably be called "green," while a deeper one will be called "red." In like manner, if a red glass, then a green one, are placed before the light alternately, and then tints of red and green of other depths, the man will often call one red, red, and the other red, green, or *vice versa*. In the display of flags that have been in use, a very bright or clean red one having been correctly called, if it be thrown carelessly near by so that it can be compared by the man, and another somewhat soiled be shown, he may pronounce the latter green, and adhere to the opinion even when he takes it in his hand, being misled by the brightness of the cleaner one, and the relative dullness of the other.

This photograph-picture of the color-stick gives in its tints only various ones of gray, since, as we know, colors are incapable of being rendered by this color-blind process, whereas color-blind men have lost but the reds and greens, preserving perfectly the power to see yellows and blues. If, therefore, we were to paint blue that part of the print

between 21 and 30, we who are not color-blind could form a clear conception of its appearance to color-blind persons, and appreciate how impossible it must be for them to conceal their defects under the investigation of the color-stick. Rose, being composed of red and blue in equal quantities, appears as a tint of blue to the red-blind, and green must look to them gray.

It has not been the duty of the writer to investigate cases of accident which might have been caused by defects of sight, but he has been assured by officials that a solution will hereafter be found in them for those hitherto insoluble mysteries where men, otherwise credible, have so flatly contradicted themselves and the circumstances of the case. By one prominent officer he was told that, being upon a train at night, delayed by some slight accident, he himself took a red lantern, and, going a proper distance back, placed himself on the track in the way of an on-coming train, but, finding his light not observed he was compelled to dash it into the cab to attract the engineer's attention, and arrest him in his progress to a collision. Upon the examination of another engineer, his superior officer being present and convinced of his marked color-blindness remarked that, but a short time before, the man had run into the rear of a train properly protected by a red light in the hands of a brakeman some distance in the rear, that the most careful investigation had resulted only in the suspension of the brakeman for not having gone far enough back, but that he was now satisfied that the color-blindness of the engineer had been the real cause of the accident. Some slight or minor accidents recently led to the discovery that another engineer had by some oversight not been tested in his division, and this led to his examination and detection there, and to his conviction by the writer as a color-blind. Still another case now presents itself. An engineer some time ago ran over and killed a brakeman, holding a danger-signal on the track in front of his engine, and no satisfactory explanation could then be given ; but the division examiner predicted that he would probably be found color-blind, and on his examination this proved to be the case.

As a fact it may be safely assumed, in the various emergencies of a railway service, by day and by night, the year round, that, if an accident could occur from such and such contingencies, it will be but a matter of time when it will become a verity.

In a recent popular article on "Control of Vision," Dr. Jeffries, who has done more than any one in this country to call attention to its necessity, laments the entire failure in Connecticut, and the partial failure in Massachusetts, to obtain efficient legislation to compel railroads to expel their deficient men. He tells us of the like condition of things in England ; and finally adds that the Pennsylvania Railway alone has availed itself of scientific advice. Perhaps if the system adopted by it had then been described and urged as most in keeping with our institutions, we might hope to see all the roads in

the country following its example ; but the advice which might be accepted, if proffered in a practicable manner, has been hitherto urged upon the officials by means of hostile newspaper articles, and agitation for legislation to place their entire extra force at the mercy of State-appointed examiners who might disorganize it and bring it into great confusion. There seems to be a natural hesitation on the part of medical men to place the examinations for color-blindness in the hands of laymen, and an equal unwillingness on the part of railroad officials to submit their force to the inspection of a numerous corps of medical examiners, but the solution is found in the use of the instrument described, which merely enables non-professional persons to make a record of certain selections and place them on paper, where they can then be submitted to a surgical expert, who can as well decide upon that evidence as though he were present at the examination, with the understanding that all doubtful cases are to be examined by him in person.

What is gained by this? The expense under the law passed in Massachusetts and Connecticut was estimated to be from two to three dollars per man, to be paid by the roads, and with a penalty of two hundred dollars for the employment of any man not provided with the certificate of an expert appointed by the Governor of the State. For this sum, say three hundred dollars per one hundred men, the road could be informed that from ten to fifteen employés were unfit for its service ; no provision was made for the correction by glasses, or other treatment of the trained men, otherwise so valuable, and no time was allowed to replace men especially fitted for certain duties ; the roads were to be thus taxed for the more than decimation of their entire force, while the employés were subjected to a pitiless scrutiny that would end in the summary dismissal of about fifteen per cent from the discharge of duties for which they had spent, perhaps, years of training. It can easily be understood why such a law would be resisted by all the political or other influences of the entire railway force in a State, from the directors and presidents to the lowest employés, and should awaken also the opposition of the holders of its securities.

By the system adopted on the Pennsylvania Railway, the men below their standard are detected unerringly by their own officials ; those color-blind are sent to the surgical expert, and after his decision are yet retained in the service where possible, being placed where their defects can work no harm. Any valuable men below the standard of visual power can be sent for treatment to their surgical expert, if the officers so decide, or the men can elect to have their defects treated elsewhere, upon the condition that they can pass the proper examination afterward. The one plan, it is evident, is expensive, irritating to the whole *personnel*, and disorganizing, while the other is economical, confidential, and orderly. By a wise liberality in aiding men to have their defects removed by proper glasses, etc., the officers of the road

have been able to carry out their wishes without any noticeable opposition from the employés, and have thus effected for hundreds what would otherwise have cost them thousands of dollars if any plan hitherto proposed had been adopted.

Since only the color-blind and those needing surgical skill have been sent to the expert, he has not been in a position to give statistical tables of the examinations, and he therefore submits the following letter from Mr. Charles E. Pugh, the General Manager, to substantiate his statements, and bear witness to the success of the entire system:

Dr. William Thomson, Surgical Expert, Pennsylvania Railway Company, 1426 Walnut Street, Philadelphia.

PENNSYLVANIA RAILWAY COMPANY, OFFICE OF THE GENERAL MANAGER,
233 SOUTH FOURTH STREET, PHILADELPHIA, PENNSYLVANIA, *April 26, 1884.*

DEAR SIR: The practical examination of our employés as to their acuteness of vision, color-sense, and hearing, in accordance with the system proposed to us by you and carried out under your supervision, has been extended to all the various divisions of the Pennsylvania Railway; has embraced nearly all of the men engaged in duties requiring the use of signals now in the service, and will be used hereafter in the selection of men placed on such duty, or in the employment of new men entering our service.

In approaching the completion of the task of examining those now in our service (more than twelve thousand employés having been submitted to your system), I desire to express to you our entire satisfaction with the rules and regulations, tests and instructions prepared by you, as well as with the personal supervision and instruction of examiners, and examinations and decisions upon doubtful cases and persons referred to you for final action.

Our division superintendents and their staff-officers have been able to deal promptly with the great majority of defective men, and thus avoid the necessity of availing themselves of that clause in the instructions which provides for an expert examination in each suspected case, and have in this way carried out your purpose without undue excitement among the men, in a speedy and confidential way, and with economy to the company.

The proportion of those defective in color-sense, vision, and hearing, was found, by the examination of two thousand men before the adoption of this plan, to be four per cent of the first and about ten per cent of the latter; and I am satisfied from my reports that all those thus deficient are being relieved of duties which they can not perform, and that the great dangers to the public, and to the other employés, of loss of life, and to the company of possible destruction of property, have been averted, so far as their defects are concerned.

I am frequently asked by prominent officers of other railways and Government officials to give an opinion as to the practical usefulness

of our system of examination, and it affords me much pleasure to emphatically commend it in all its details; and I feel that we have good reason to be satisfied with this, the first successful attempt to bring the entire body of men engaged in signaling upon a railway in our country under control by the practical application of scientific facts. Having eliminated these dangerous persons from our present force, we propose to keep it free from them in the future by a steady application of our present system. Yours truly,

Charles E. Pugh, *General Manager.*

To this great corporation, extending through six States, operating five thousand miles of track, with nearly if not quite fifty thousand employés, and responsible for the lives of millions of people each year, must be accorded the honor of having been the first to obtain the desired control of the visual defects of their men by a wise and intelligent application of scientific laws. Their example has been extensively followed elsewhere, and their instrument has been obtained by more than thirty other roads from the manufacturers. It has also been ordered by "The Board of Trade of England," by many distinguished medical men abroad, and has recently been, with the entire system, adopted, and will no doubt be put into operation by a director of the Southwestern Railway in England. There is no longer any reason why losses of life and property should occur in railway service from visual defects; and an enlightened public opinion should now insist upon the adoption of some similar plan upon the hundred thousand other miles of railway now being operated in our country.

Having been placed as the American representative on the Committee on Control of Vision at the International Medical Congress in London three years ago, I have urged upon the Naval Committee of our Congress the value of this large experiment, with a view to have a law passed to form an International Commission to establish a uniform system of signals, examinations, etc., both on the land and on the water. There is no doubt that accidents must occur on the sea; and the recent loss of the Tallapoosa has not only been ascribed to a wrong interpretation of the colored signals, but the commission appointed to investigate the accident has been especially directed to examine for color-blindness the lookouts on the two ships.

CALCULATING-MACHINES.

By M. EDOUARD LUCAS.

WHEN I was a little boy, I sometimes went for the bread to a short distance from the house. The baker would take my tally-stick, put it alongside of his, and cut a notch in both. Then I would go away with my bread and the baker's account on the tally-

stick. At the end of a fortnight or a month the tally-notches were reckoned up and the account was settled. The number of notches represented the number of loaves of bread bought, and this number, multiplied by the price per loaf, gave the amount of money I had to take to the baker.

Although in our present article we shall make use of systems of numeration, and particularly of the decimal system, it is proper to observe that the most important properties of numbers are independent of such systems, and that they are used by the arithmetician in his calculations only for aids, as the chemist uses bottles and retorts. We give two specimens of properties of numbers, which we see illustrated in the problems called the flight of cranes and the square of the cabbages. Cranes in their flight dispose themselves regularly in triangles. We wish to get a rule for finding the number of the birds when we know the number of files; or, supposing that we have arranged the files with increasing numbers from unity to a determined limit, we seek to find the total of the unities contained in the collection. To make the matter plainer, let us seek the sum of the first six numbers, or the number of units represented to the left of the broken line in Fig. 1, by the black pawns. We will represent the same numbers, in an inverse order, by white pawns, to the right of the same line. We shall see at once that each horizontal line contains six units *plus* one; and, since there are six lines, the number of units in the whole square is six times seven. The number we are seeking, then, or the number in the half-square, is half of forty-two, or twenty-one. The same reasoning may be applied

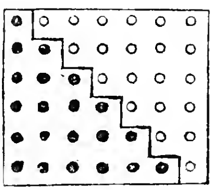


Fig. 1.

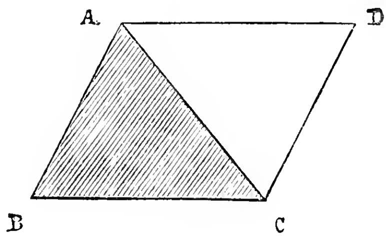


Fig. 2.

to any number; so the sum of the first hundred numbers is half of a hundred times a hundred and one, or 5,050. Therefore, to obtain the sum of all the numbers of any series beginning with unity, all that is necessary is to take half the product of the last number of the series by the next one. An analogue of this mode of reasoning appears in the geometrical demonstration of the proposition that the area of the triangle A B C (Fig. 2) is half that of the parallelogram A B C D, of the same base and height; and reflection will show us that the arithmetical and the geometrical theorems are really one. The numbers we have just learned to calculate, which represent all collections of objects regularly disposed in triangles, are called triangular numbers. The

theory of these numbers was born on the Nile at a remote epoch, and was developed by Diophantes, the father of arithmetic, at the school of Alexandria. In his treatise occurs the proposition, giving, as an essential condition of such a number, that the octuple of a triangular number, augmented by unity, is a perfect square. This fact is made evident by the examination of the diagram (Fig. 3).

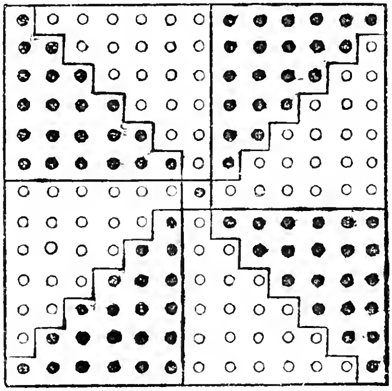


Fig. 3.

An arithmetical progression is a series of numbers in which each member is equal to the preceding member, *plus* a constant number which is denominated the common difference. Thus the odd numbers one, three, five, seven, nine, eleven, form an arithmetical progression, the common difference of which is two. We can demonstrate, as was done in the preceding case, that the sum of the terms in such a procession is equal to the product of the number of terms by the half-sum of the extremes; and, in the same way, the area of a trapeze is half the area of a parallelogram of the same height, the base of which is equal to the sum of the bases of the trapeze (Fig. 4).

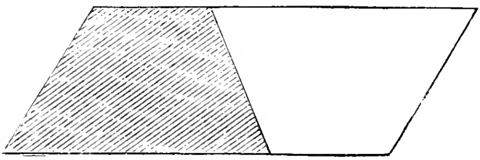


Fig. 4.

Our second example is borrowed from Plato. Fig. 5 represents a square of cabbages. To get the number of cabbages contained in the square, we multiply by itself the number on one of the sides. We have marked lines bounding the successive squares that contain one, two, three, four, five, or six cabbages to the side. Now observe the difference between the numbers of cabbages in one square and the next one. We find that the numbers included in the successive inclosures bordered by our lines are one, three, five, seven, nine, eleven; and we perceive, by reference to the short dotted lines, that the number from one inclosure to another increases by two. We come at once to the propo-

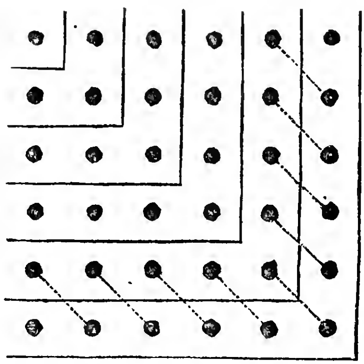


Fig. 5.—The Square of Cabbages.

sition that the sum of the odd numbers, beginning with unity, is the square of their number. Thus, the sum of those numbers between 1 and 199 is a hundred times 100, or 10,000.

Suppose we desire to make a table of the squares of all the numbers up to 1,000, for example, the way that first suggests itself is to make a thousand multiplications, 2×2, 3×3, to 999×999. But this method is of little value; it is exceedingly long, and there is no way of verifying it. We have a surer and more expeditious method. Fig. 6 represents the table for calculating the squares of the first ten numbers. The column D_2, which need not be written, contains 2's; column D_1 represents the series of odd numbers, and may be written offhand; column Q may be formed after the following law, which applies to all the numbers in the table: *Each number is equal to the one above it in the same column, augmented by the one that follows it in the same line.* Thus, $81=64+17$; and $19=17+2$. A thousand additions of two numbers will then be sufficient to construct our table up to the square of 1,000. But here, it may be said, the results all depend one upon another; any error will carry itself to the next computation, and grow, like a snow-ball that at last becomes an avalanche, and overthrow the whole calculation. The remedy for this inconvenience is easy. When we have got the squares of the first ten numbers, we have only to add two ciphers to have the squares also of the

N.	Q.	D_1.	D_2.
1	1	3	2
2	4	5	2
3	9	7	2
4	16	9	2
5	25	11	2
6	36	13	2
7	49	15	2
8	64	17	2
9	81	19	
10	100		

FIG. 6.—SQUARES.

N.	T.	D_1.	D .
1	1	2	1
2	3	3	1
3	6	4	1
4	10	5	1
5	15	6	1
6	21	7	1
7	28	8	1
8	36	9	1
9	45	10	
10	55		

FIG. 7.—TRIANGULAR NUMBERS.

numbers 20, 30, 40, etc., to 90; we write them immediately in the place they should occupy; and then we must get the same numbers again at the proper places in the course of our operations.

An arithmetical progression of the second order is one in which, if we form a series of the excesses of each number over the preceding one, we obtain numbers in arithmetical progression. Of this order are the series of the squares, and of the triangular numbers (Fig. 7).

There may be also arithmetical progressions of the third and fourth orders, and so on to infinity. They are all calculated in the same manner; and we take for a single example the series of the cubes of whole numbers, which form an arithmetical progression of the third

order (Fig. 8). We get by direct calculation the first four terms, 1, 8, 27, 64; then, by subtraction, the first three terms of the column D_1, the first two of the column D_2, and the first term, 6, of D_3. The table is then completed by the law given above.

N.	C.	D_1.	D_2.	D_3.
1	1	7	12	6
2	8	19	18	6
3	27	37	24	6
4	64	61	30	6
5	125	91	36	6
6	216	127	42	6
7	343	169	48	6
8	512	217	54	
9	729	271		
10	1000			

FIG. 8.—CUBES.

These explanations are necessary to enable the reader to comprehend the function and classification of calculating-machines. The method which is expounded in them appertains to the calculation of differences, and is applicable to all kinds of computations, whether of days' works, tables of interest and annuities, sinking-funds and insurances, tables of logarithms, astronomical tables, or the resolution of numerical equations.

Numeration is based on the theory of geometrical progressions, by which name we call a series of numbers in which each member is equal to the preceding member, multiplied by a fixed number that is called the *ratio*. Thus the numbers 1, 10, 100, 1,000, 10,000 form a progression of which the ratio is ten, or a *decimal* progression. The numbers 1, 2, 4, 8, 16, 32, 64, the ratio of which is 2, form a *binary* progression.

The ancient Tartar hordes communicated with each other by means of sticks notched in an understood manner, so as to indicate the number of men and horses which each camp was expected to furnish. The Inca-Peruvians had knotted cords of various colors, that could be tied in a thousand ways; and the number of knots, their arrangement, the tying of them with sticks, or around a central ring, permitted the expression of a variety of ideas, and of considerable series of numbers. The art of calculation is taught to children in some schools by means of apparatus consisting of a frame with ten rods, on each of which are strung ten counters; and the same kind of an apparatus is managed by the Chinese with much dexterity.

We propose, as an important aid to be used in teaching arithmetical calculation, a vertical checker-board, the squares of which are furnished with pegs on which pawns may be slipped. No distinction is to be made between the white and black squares. We begin by placing ten black pawns in the squares of the lower horizontal row. Lift the pawns in succession from the right, counting one, two, three, up to nine. This

brings us to the top of the column. Take the pawn back to its zero-place, and lift the pawn in the next column, up one place, calling it ten. Then we begin with the right-hand pawn again, two, and count eleven, twelve, etc., to nineteen. Then bring the first pawn back to

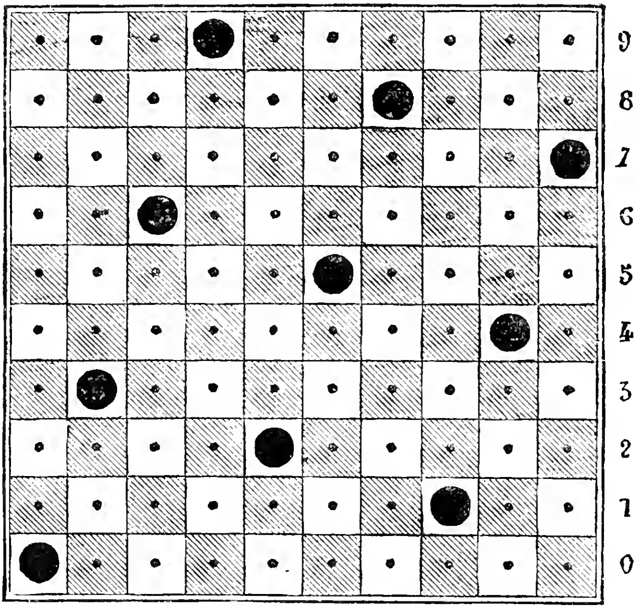


Fig. 9.—The New Universal Abacus.

zero, and, lifting the second pawn to another square, call it twenty, to which we may add the units formed by raising the first pawn, as before. So we may go on with all the pawns, giving each successive piece, as we go to the left, ten times the value of the preceding one.

Our new abacus has the advantages that the value of its places increase in the same direction as the written numbers they represent, while the counters increase in arithmetical value as they are raised higher. As arranged in the cut the board represents the number 0,369,258,147. The capacity of this table, which is now equal to the expression of a thousand millions, may be indefinitely increased by adding columns to the left. The capacity of the board may also be changed by adding to it or subtracting from it in a vertical direction, whereby, instead of counting by tens, hundreds, and thousands, we may count by dozens, grosses, and so on, or by multiples of eight, six, four, two, or any other number. Every system of numeration is thus founded on the employment of units of different orders, each of which contains the preceding one a certain number of times, or, in other words, upon a geometrical progression, the ratio of which is called the base of the system. Aristotle observed that the number four might take the place of ten, and Weigel, in 1687, published a

plan of a quaternary arithmetic. Simon Stevin, of Bruges, had previously devised a system of duodecimal numeration like the one we use in computing time and the degrees of the circle. The almost unanimous choice of the number ten as the basis of numeration was probably suggested by the ten fingers.

Instead of increasing the height of our abacus by two squares to explain the duodecimal system, let us put in its place a rectangle two squares high and of any desired width. We shall then have the system of binary numeration, and be able to write all the numbers with only two figures, 0 and 1. The numbers one, two, three, four, five,

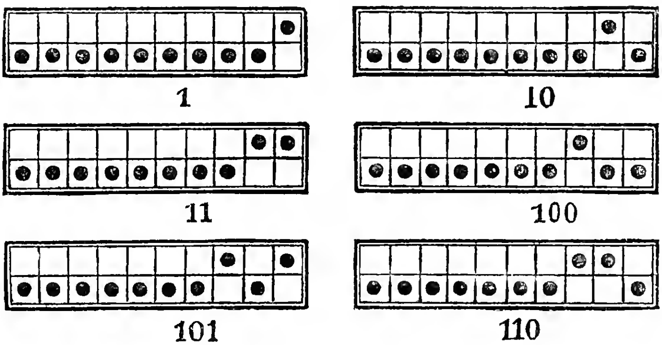


FIG. 10.—THE BINARY ABACUS.

and six, may be formed on this system as in Fig. 10. This system furnishes the explanation of the Chinese symbol "Je-Kim, or Book of Mutations," which is attributed to the venerable Emperor Fo-Hi. It is composed of sixty-four figures, each formed of six horizontal lines written one over the other, some of them whole, others broken in the middle. The whole lines represent units of different degrees, rising from the lowest, and the broken lines zeros.

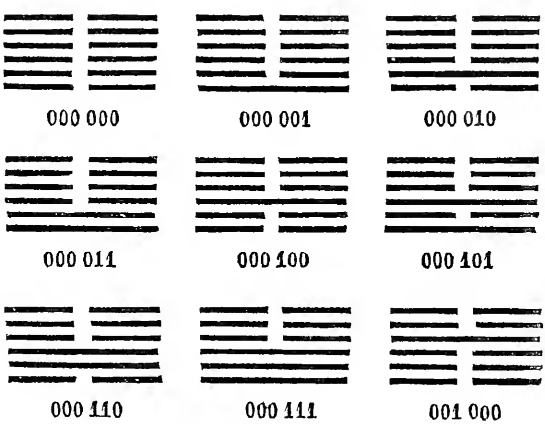


FIG. 11.—THE NINE FIRST CHARACTERS OF THE JE-KIM.

To return to our binary abacus: suppose the first pawn on the right weighs a gramme, the second two, the third four, and so on, doubling to the twelfth, which will weigh 512 grammes; with these twelve weights we can weigh all the whole numbers of grammes to 1023, the sum of all the preceding numbers. The principle is the same, fundamentally, as that of the well-known ring-puzzle. A game was published toward the end of last year, professedly of Indo-Chinese origin, which was called the Tower of Hanoi. The tower was composed of successive stones, decreasing in size as they rose, and represented by pawns, or buttons slipped upon a peg. The game consists in taking the pawns off from the peg and arranging them upon one of two other pegs in such a manner that only one of them shall be removed at a time, and a larger one shall never be put upon a smaller one (Fig. 12). The game is always possible, but demands twice as many removals and twice as much time for each story that is added to the tower. Having learned to rebuild the tower for eight stories by removing it from the first peg to the second one, the problem is made easy enough for one of nine stories; we first remove the eight upper stories to the second peg, then put the ninth story upon the third peg, and rebuild the eight stories upon it. To perform the operation, we must make, for a tower of two stories, at least three removals; for one of three, 7; for one of four, 15; for one of five, 31; for one of six, 63; for one of seven, 127; for one of eight stories, 255 removals. If it takes a second to make one removal, the rebuilding of a tower of eight stories will require four minutes. If the tower consists of sixty-four stories, the readjustment will

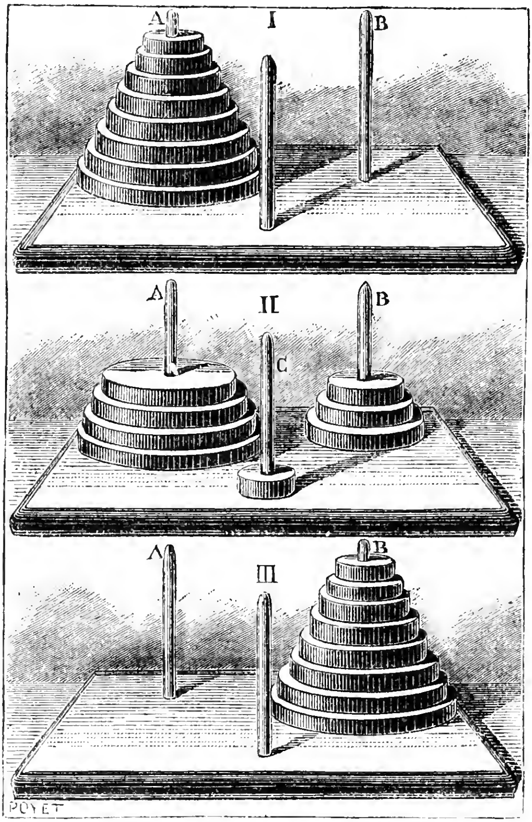


Fig. 12.—The Tower of Hanoi. I. The tower at the beginning of the game; II. Illustrating the process of the removal of the stories in the rebuilding of the tower; III. The tower rebuilt.

be a matter of 18,446,744,073,709,551,615 removals, and will occupy five million centuries. This prodigious number comes up again when we calculate the theory of the ring-puzzle of sixty-four rings. According to an ancient Indian legend, the Brahmans took their turns day and night on the steps of the altar in the temple at Benares, to execute the readjustment of the sacred tower of Brahma, of sixty-four stories, of fine gold set with diamonds. When they had done, the tower and the Brahmans would fall together, and then would be the end of the world. The principle of this game corresponds with that which is the basis of the binary system. By increasing the number of pins, and slightly modifying the rules, we can make it represent other systems.

The first machine for executing calculations by mechanical movements was invented by Pascal in 1642. It is illustrated in Diderot's "Encyclopædia," and in some editions of Pascal's works.

Every arithmetical machine is composed of four organs: the generator, the reproducer, the reverser, and the effacer. In Pascal's apparatus and in Roth's most recent modification of it the generator is very rudimentary, being nothing but a rod held in the hand. The reproducer is composed of wheels with ten or twelve cogs, mounted on parallel axes, the first wheel on the right representing units, the second tens, the third hundreds, and so on. Each of the wheels bears one or more sets of figures from 0 to 9, and has in front of it a sheet of metal pierced with an opening through which a single figure can be seen at a time. The mechanism is so adjusted that each wheel after the first one advances by one division or tooth as the wheel to the right of it advances from 0 to 9. Over the circumference of each wheel a notch in the covering-plate allows the generator-rod to be applied to the teeth of the wheel to move it as many numbers as may be desired. We can thus, by successive pushings and readings, perform any additions we wish. Multiplication is performed by successive additions, but the process is slow and tedious, on account of the inefficiency of the generator. The object of the third organ, the reverser, is to change addition into subtraction, and multiplication into division. In Pascal's machine, each of the figure-bearing cylinders of the counter carries two scales, the reverse of each other, on parallel circles, the sum of the corresponding figures on which is always 9; so that the addition of four units of any order on one of the scales effects a subtraction of four units on the other scale. The object of the fourth organ, the effacer, is to bring all the numbers back to zero. In Roth's machine, 9 is made, by turning a button, to appear in the addition scale at all the openings; then the wheel is pushed around by the generator so as to add one, and 0 appears in the place of the 9.

The Thomas arithmometer is a much more perfect and practicable machine. The generating apparatus is composed of a horizontal metallic plate, having parallel grooves, along which are written the figures from 0 to 9. Each groove has corresponding to it a button

with an index, which may be slid in the direction of its length, and by means of which we can enter any number we choose. Each button is connected by a pendent wire, with a ten-toothed pinion, below the tablet. By the side of each of the pinions is a cylinder with a horizontal axis, the length of which is the same with that of the grooving above it. Each of the cylinders bears projecting, upon half the circumference, nine nerves of successively increasing length, from $\frac{1}{10}$ to $\frac{9}{10}$ the length, and the motion of each cylinder is commanded by a horizontal shaft, which is turned by a crank. The cylinders make a revolution with each turn of the crank, but the pinions advance, each only according to the number of teeth marked by the corresponding index. Pinions mounted on the same axis with the index transmit the motion to the figure-bearing wheels of the reproducer, which is placed under a metallic plate, prolonging the first one. Each turn of the crank produces the successive terms of an arithmetical progression. Suppose we wish to multiply 37,456 by 435. We bring down to zero the figures opposite the openings in the reproducer by means of an effacer, which is to be described. We write on the tablet the number 37,456; then turn the crank five times, when we will be able to read through the opening the product of 37,456 by 5; to get the product by 35, we would have to turn 35 times, but for an ingenious disposition by which we push the whole apparatus a notch to the right, and turn three times, which gives the product we are seeking; then pushing another notch to the right, and turning four times, we have the product by 435. The function of the reverser may be best explained by a comparison. Suppose a carriage of two wheels and an axle-tree, and a person is riding upon it holding an opened umbrella. As long as the umbrella is held straight over the middle of the axle, it does not move; incline it over one of the wheels, it begins to revolve; incline it over the other wheel, it will turn in the contrary direction, while the carriage will be all the time going straight ahead. In the arithmometer, the wheels of our carriage are replaced by twin-pinions and the umbrella by the figure-bearing wheel of the reproducer. By pushing on a little lever, we bring whichever pinion we desire into gear with the figure-bearing wheel, so that each turn of the crank—it always turning in the same direction—brings successively before the openings numbers increasing or decreasing in an arithmetical progression, of which the common difference is marked on the abacus of the tablet.

Lastly, the effacer illustrates the advantage that may be drawn from a broken tooth. Below each figure-bearing wheel is found, solid with it, another smaller toothed wheel in which the tooth corresponding with the 0 below the peep-hole is suppressed. A roweled button pushes along a rack, that keeps the wheel turning, till the moment when the 0 is to appear before the opening. The operation is performed with extreme rapidity, and is one among many admirable details in the per-

formance of the machine. With this instrument, which my children learned to use when they were seven years old, the product of two numbers of ten digits can be obtained in half a minute ; and it is used in numerous offices and institutions in France, the average sale of it being a hundred a year.

About a half a century ago, Charles Babbage undertook the construction of a universal calculating-machine, which should give the successive terms of arithmetical progressions of different orders ; but, having devoted the latter part of his life, and all of his fortune and income to it, died without finishing it. George Scheutz, of Stockholm, and his son, Edward Scheutz, exhibited a machine at the Paris Exposition of 1855, which was bought by a citizen of the United States and presented to the Dudley Observatory in Albany. It is shaped like a small piano, and by simply turning the handle gives out the successive terms of arithmetical progressions, not of the first order only, but of the second, third, and fourth orders.

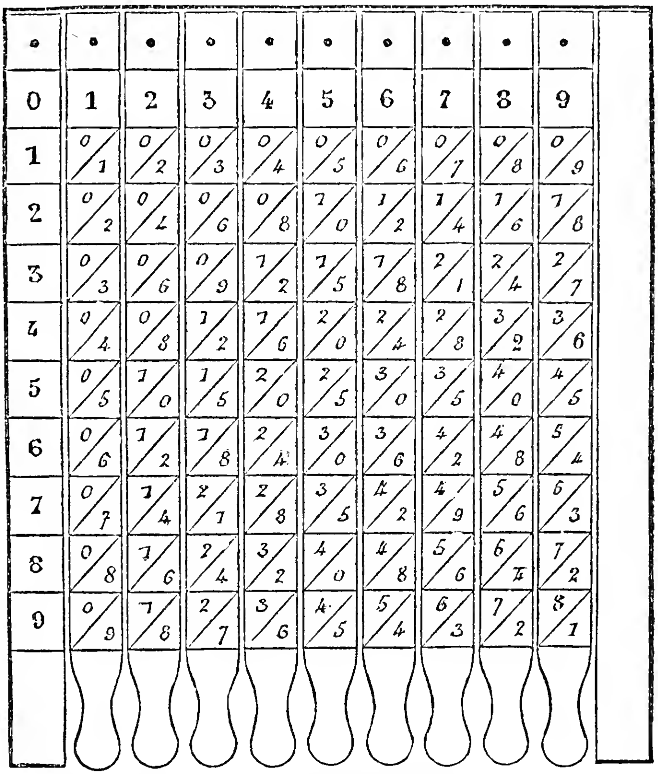


Fig. 13.—The Table of Pythagoras on Slats.

John Napier, the inventor of logarithms, suggested an ingenious method of performing the operations of multiplication and division. The table in Fig. 13 represents the table of Pythagoras dissected into

ten slats, of which the one on the left is fixed, while the others are movable and can be changed about at pleasure. Each of the squares of the table is divided by diagonals into two triangles, in the lower one of which is found the figure of the units of each of the products, and in the upper and left one the figure of the tens. If we place by the side of the fixed bar the slats bearing at the top the numbers 7, 5, and 8, we obtain almost immediately the products of 758 by all the numbers from 1 to 9. Thus, before the 6 of the fixed bar, we find, looking horizontally, 6 | $\frac{4}{2}$ | $\frac{3}{0}$ | $\frac{4}{8}$ | ; and by making the addition parallel to the diagonals, we have 4548 as the product of 758 by 6. The other products are got in the same manner. These slats then permit us to find rapidly—without having to know the table of Pythagoras, but by the simple addition of two figures—all the partial products by a number of ten figures. Thus, multiplication is again brought back to addition. This invention, however, has not become practical, because of the difficulty of finding the products when the multiplicand has two or more similar figures. An invention of our own gives it a more practical form. We have replaced the slats by square rules, containing four different numbers on each of the four faces, by which four tables of Pythagoras are included in the same space. But a little addition is still required for finding each of the partial products. M. Henri Genaille, an engineer of the state railroads, has devised a plan for substituting these additions by simple designs, that will permit all the partial products to be read instantly. The management of the rules is very simple, and may be learned at once. As perfected by us, this apparatus replaces the operations of multiplication and division by a simple addition, or a subtraction. With the boxes of the Genaille rules, each eighteen centimetres long, twelve wide, and one thick, we can obtain the partial products of all the numbers to twenty figures. With another disposition of the rules, on a larger scale, it will be possible to give all the products of numbers of ten figures by other similar numbers.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE LARGER IMPORT OF SCIENTIFIC EDUCATION.*

By J. W. POWELL, LL. D.

THE establishment of a School of Science and Arts at the capital of the nation, through the munificence of Washington's venerable philanthropist, is a landmark in the progress of culture and the history of education, and shows that the demands of modern culture are fully recognized. Let us briefly glance at some of the characteristics of this new education.

* From an address delivered at the inauguration of the Corcoran School of Science and Arts, in the Columbian University, Washington, D. C., October 1, 1884.

Scientific education is catholic; it embraces the whole field of human learning. No student can master all knowledge in the short years of his academic life, but a young man of ability and industry may reasonably hope to master the outlines of science, obtain a deep insight into the methods of scientific research, and at the same time secure an initiation into some one of the departments of science, in such a manner that he may fully appreciate the multitude of facts upon which scientific conclusions rest, and be prepared to enter the field of scientific research himself and make additions to the sum of human knowledge. Honest investigation is but the application of common sense to the solution of the unknown. Science does not wait on Genius, but is the companion of Industry. Under the *régime* of the elder education, the larger number of those who prepared themselves to be scholars, by acquiring the languages in which scholarship was embodied, never passed beyond the portal to knowledge, but speedily fell back into the ranks of the unlearned. Only the few went on to explore the fields open before them; *many were called, but few were chosen.* Scientific education takes men at once into the very midst of the new philosophy.

There is no calling in life to which a cultured man may properly aspire in which a scientific training is not essential to success. This can not here be fully set forth, but some illustration may be given. If the scholar would devote himself to law—law itself is now a science, and, in the application of the principles of law to facts as they exist in modern civilization, a general knowledge of the facts which constitute the body of science is essential. In the East some of the greatest lawyers of the land are to-day engaged in gigantic litigation relating to the invention of the telephone, and in the far West other great lawyers are engaged in litigation relating to mines, which involve the facts and principles of geology. On every hand are kindred illustrations.

But there is a line of facts in the history of law which peculiarly illustrates this proposition. In savagery and in barbarism despotism is not highly developed. The greatest despotisms of the world were established in early civilization. In the main these despotisms were established on four fundamental ideas: first, there was property in man; second, tenure to land was feudal; third, the king was the fountain of justice; fourth, facts were established by compurgation. The last is of interest here.

In early civilization there were no proper legal methods by which to determine the facts involved in legal controversy, and, when courts were convened and juries organized, the facts were to be obtained from the averments of the interested parties, and no system of assembling evidence by witnesses, as now known in our courts, then existed. The parties to litigation, civil or criminal, made their statements and substantiated them by compurgators. Every man in an ancient commu-

nity was supposed to have his friends who would vouch for the truth of his statements, and he stood best before the courts whose vouching friends or compurgators were the most influential. No device for the establishment of despotism and wrong has ever been more efficient than the system of compurgation.

In modern legal practice all this has been changed, and the law of evidence has been vastly developed, until it constitutes one of the most important departments of law; and to-day, in the hearing of cases, the larger share of the time is devoted to the establishment of the facts, and the greatest skill of attorneys is exercised in this branch of the case; and every great lawyer and jurist now understands that it is easier to grasp the principles of the law than to reach the facts which should guide in their application. Thus it is that a knowledge of the facts and the principles of science is essential to him who would be successful as advocate or as judge.

Perhaps the student aspires to be an historian. In the past, history has been devoted chiefly to the exploits of heroes and the story of wars; but history is now being speedily reorganized and rewritten upon a scientific basis, to exhibit the growth of culture in all its grand departments. History itself is now a science, and is no longer an art in which men exploit in rhetorical paragraphs.

In many ways and on every hand it can be shown that scientific education furnishes the training that is needed for life in modern civilization.

I refrain from alluding to the relations of such a school to the stupendous industrial accomplishments of modern civilization, and to the training demanded thereby; first, because that field has already been well cultivated; and, second, because it has been lately assumed that scientific education is wholly utilitarian. It is true that all utilitarian training is scientific, but that is not the only characteristic of scientific training—it is catholic, it is universal.

Scientific education gives the highest mental training; scientific education means a training in modern scientific culture. What this culture is, has already been outlined. It is the product of all the mental endeavor of the race to which we belong. This struggle for improvement, this grand endeavor to secure happiness through human activities, which have been defined as the humanities, began in remote antiquity. Where our race lived in savagery, we know not. All we know is that at some time and in some place our ancestors were savages. In Asia and in Europe and in Africa this struggle was continued. Slowly and painfully, with many misfortunes and many reversions, the Aryan race has steadily moved forward in the march of culture, and every branch of the race has contributed its part. Every great artisan and artist, every great statesman, every great linguist, every great philosopher, every great thinker in all that time, has contributed his part; and, more than this, our race has borrowed from

the other races of the world everything which they could contribute worthy of our acceptance.

Modern culture, therefore, stands as the product of all mental endeavor for all time. It may, then, be safely assumed that the study of that which has made civilization, and *is* civilization in its highest form, and which is the result of all the training of all the world, must itself furnish the best subject-matter for training that human ingenuity can devise.

Scientific education is æsthetic training. To purblind ignorance the beauties of the world are dimly seem, but the glory of the universe is revealed by science. Classic poetry was the best literary product of its time, because it was informed by the philosophy of its time. Its philosophy was chiefly mythology, and the characters of ancient poetry are mythic heroes and gods. So the highest literature of the new civilization must be informed by its highest philosophy ; it must be instinct with that knowledge of the universe which is now the glory of the scholars of the world. The splendors of the heavens and the earth, as known to modern science, have put in eclipse the dull glories of ancient mythology.

Scientific education is a training in mental integrity. All along the history of culture from savagery to modern civilization men have imagined what ought to be, and then have tried to prove it true. This is the very spirit of metaphysic philosophy. When the imagination is not disciplined by unrelenting facts, it invents falsehood, and, when error has thus been invented, the heavens and the earth are ransacked for its proof. Most of the literature of the past is a vast assemblage of arguments in support of error. In science nothing can be permanently accepted but that which is true, and whatever is accepted as true is challenged again and again. It is an axiom in science that no truth can be so sacred that it may not be questioned. When that which has been accepted as true has the least doubt thrown upon it, scientific men at once re-examine the subject. No opinion is sacred. "It ought to be" is never heard in scientific circles. "It seems to be" and "we think it is" is the modest language of scientific literature.

In science all apparently conflicting facts are marshaled, all doubts are weighed, all sources of error are examined, and the most refined determination is given with the "probable error." A guard is set upon the bias of enthusiasm, the bias of previous statement, and the bias of hoped-for discovery, that they may not lead astray. So, while scientific research is a training in observation and reasoning, it is also a training in integrity.

Scientific training is an education in charity. Sympathy for the suffering of others is at the basis of eleemosynary charity, and it has grown with the development of social interdependence. The charity that was born in the family in primitive times, with the growth of the tribe into the nation, has developed into national charity, and finally,

in modern civilization, it has become the great principle of philanthropy. Now the sufferings of all mankind touch the hearts of all men. If a tornado destroys a village, the whole world tenders alms; if a party of heroes are starving in the ice-fields of the North, their sufferings kindle sympathy in the heart of every civilized man.

But there is a charity unknown to tribal society, and little known in early civilization—a charity born of knowledge, a charity kindled in the hearts of men by science. It is charity for men's opinions—philosophic charity. In all the past, he whose opinions were not in conformity with current beliefs was held to be depraved, and hemlock was his portion, or fagots were used for his purification.

It has at last been discovered that the world has always been full of error, and we are beginning to appreciate how man has struggled through the ages from error to error toward the truth. We now know that false opinions are begotten of ignorance, and in the light of universal truth all men are ignorant, and as the scholar discovers how little of the vast realm of knowledge he has conquered he grows in philosophic charity for others. The history of the world is replete with illustrations to the effect that the greater the ignorance the greater the abomination of unconforming opinion, and the greater the knowledge the greater the charity for dissenting opinions.

EVOLUTION AND THE DESTINY OF MAN.

By W. D. LE SUEUR.

"THE Destiny of Man viewed in the Light of his Origin" is the important and interesting subject to which Professor Fiske devotes the last work that has issued from his pen. It is as true to-day as it was in the days of that Northumbrian king whose reason for hearing the Christian missionaries has so often been cited with approval, that men have a longing to know what may lie beyond the portal of death which closes so solemnly and, as it would seem, mysteriously upon all the activities of life. The Christian religion has been answering the question in its own way for well-nigh nineteen hundred years, and it might not be too much to say that upon that answer, authoritatively given, more than upon anything else, its wonderful and prolonged vitality has depended. What troubles the minds of many to-day is a doubt as to whether there are solid and reasonable grounds for what has so long been taught with authority. Was the tone of certainty assumed by Christian teachers at the outset anything more than a strong persuasion due to the workings of imagination? Does the answer so confidently given, and so devoutly accepted by countless multitudes in past ages, still hold good? Is the soul of man

something altogether apart from his bodily frame? Does it maintain its individuality, its elemental purity, while the body falls asunder? Does it necessarily endure eternally? And is it true that, the coil of earthly life once shaken off, every human soul departs into a condition either of everlasting bliss or of everlasting and unspeakable torment? To all of these questions the Christian religion has answered, and must still answer, "Yes." In what respect, then, it may be asked, does Professor Fiske seek to modify the Christian message; or does he simply state over again, on the authority of Science, what Christianity had affirmed on the authority of supernatural revelation?

In reply to these queries it may be briefly stated that Professor Fiske confines himself to asserting, in the name of Science, and particularly of the doctrine of evolution, the separate and essentially independent existence of the human soul. Whether, such being the case, he can claim to have thrown any light on the *destiny* of man, is perhaps a debatable point. It seems to me that he has rather dealt with the statics of human nature than with the question of the final outcome of human activity. It may be doubted whether, if the Christian missionaries at the court of the Northumbrian king had contented themselves with announcing that man had a soul, and that the soul was imperishable, they would have made much impression on their heathen listeners. Animistic interpretations of the phenomena of human life have been common in all ages—so common that, from their apparent universality, Mr. Spencer deduces the conclusion that all religion is based on primeval ghost-worship. Mr. Fiske comes forward to-day to say, in effect, that animism has the warrant of Science. Well and good! It may have; that all depends upon the interpretation of facts. But establish the point, and we shall at once want to know what are the fortunes of the soul after it leaves the body. Does it repair to happy hunting-grounds? Does it wander in a meadow of asphodel? Does it flit about in eternal twilight? Does it repair to the court of Minos and Rhadamanthus? Does it take on other animal forms and so revolve through a ceaseless round of changes? Or does a judgment await it that will place it irrevocably on one side or the other of the eternal dividing line, the everlasting gulf, which shall separate the saved from the lost? Unless some one will answer these questions for us, it seems almost vain to pretend that any light has been thrown on the "destiny of man" (beyond the present life) by the mere assertion, on whatever grounds, that the "soul" is something essentially distinct from the body.

It may be further affirmed that even the latter statement, when taken by itself, will prove unsatisfactory, unless a clear delimitation is established between what belongs to the soul and what to the body. It is to be feared that there is much the same uncertainty and vagueness in the use of the word "soul," which Matthew Arnold, in his "Literature and Dogma," has signalized in the case of the word "God." Peo-

ple think they know what they mean, and that they all mean the same thing, when they use the word "soul." But do they? If we are to attach importance to the doctrine that the soul is not of the same nature as the body, and exists, or can exist, apart from the body, it is surely above all things necessary that we should hold some orthodox creed as to what the soul is in itself, and what the body is in itself—what, in a word, each is that the other is not. It might have been expected that a writer of the scientific habit of mind of Mr. Fiske would have presented some definition of the word "soul" in the work before us; but I fail to find that he has done so. We are left in this matter entirely to our own more or less vague preconceptions. It would have been satisfactory could we have been informed whether the soul, in parting from the body, carries away with it any elements or influences derived from the body, or whether it simply reverts to the condition in which it existed before its union with the body. Some information of this nature is necessary before we can be sure that our knowledge is much advanced by being told that the soul continues to exist after the body has been dissolved. What, exactly, continues to exist? How much of what we now reckon as ourselves? Then, again, though it might not, strictly speaking, form part of the discussion as to the *destiny* of man, it would seem proper that a scientific expounder of animism should at least hazard some conjecture as to where or what souls are before their union with bodies; whether they exist individually or whether they are but parts of some homogeneous soul-substance,* and only become individualized as the result of their union with individual bodies. Especially might we look for this when the subject discussed is "the destiny of man viewed in the light of his origin." If there be the sharp distinction affirmed between man's soul and his body, we should hardly expect the natural history of his body to throw much light on the destiny of his soul. We should certainly be better prepared to form an opinion or a belief as to the course of the soul after it leaves the body, if we could have some grounds for an opinion or belief as to the mode of its existence before it joined the body. If it be held that it had no previous existence, it may not be evident to all why it should survive that body at a certain point in the development of which it would seem to have had its birth.

These are preliminary considerations. Mr. Fiske has not given us all that might have been expected in a treatise bearing the title he has chosen, and pointing to the conclusions he indicates. Still, he has given us something, and it may repay us to examine what the actual content of his work is. To say that the work is written with grace and charm and skill, is only to say over again that it proceeds from the pen of Mr. Fiske. What we want to know now is, what it teaches us apart from lessons in literary style and arrangement.

* Compare Maudsley's theory of an all-pervading mentiferous ether, "Body and Will," p. 101.

In examining this work, small as it is, we seem to discover, as it were, traces of collaboration. It has the appearance of having been written not by one Mr. Fiske, but by two Mr. Fiskes. The first is Mr. Fiske, the simple student of science and recorder of scientific facts; the second is an author who apparently can not rest content with facts as they are, but constantly strives to view them in the light of some foreign hypothesis. The second Mr. Fiske would appear to have edited the first rather than the first the second; yet the work has been done in such a way that the diverse elements can easily be distinguished and separated.

The scientific Mr. Fiske discourses thus: As the Copernican theory destroyed the notion that the earth was infinitely larger than all the heavenly bodies, and was the center of the universe, thus giving a violent shock to the theological beliefs of the period, so the Darwinian theory to-day has destroyed the notion, prevalent up to the present time, that man occupies a position wholly apart from the rest of the animal creation. It enables us to state that "man is not only a vertebrate, a mammal, and a primate, but [that] he belongs, as a genus, to the catarrhine family of apes"; further, that "the various genera of platyrrhine and catarrhine apes, including man, are doubtless descended from a common stock of primates, back to which we may also trace the converging pedigrees of monkeys and lemurs, until their ancestry becomes indistinguishable from that of rabbits and squirrels." There is no more reason for supposing that this conclusion will ever be overthrown than there is for supposing that the Copernican theory will be banished and the Ptolemaic restored. The facts which once furnished support to the "argument from design" have received at the hands of Mr. Darwin a very different interpretation. It is "that simple but wasteful process of survival of the fittest," which is now invoked to explain the marvels of adaptation with which Nature abounds. "The scientific Darwinian theory alleges development only as the result of certain rigorously defined agencies. The chief among these agencies is natural selection." A point, however, arrived, in the development of the brute-ancestor of man, when psychical changes began to be of more use to him than physical changes; in other words, when better-developed brains began to have the advantage over better-developed muscles. From that point onward the brains of our progenitors steadily increased "through ages of ceaseless struggle," not only in size but in complexity of structure. So far, therefore, as man was concerned, "the process of zoölogical change had come to an end, and a process of psychological change was to take its place." A difference in kind was thus established between man and the lower animals, the result of the accumulation of differences of degree. In the same way we see a difference in kind established between a nebula and a solid sphere through the operation of a gradual process of cooling and contraction. Upon this point there should be no mistake, for it is thus that all differences

in kind are brought about. The result of the increasing size and complexity of the human brain, and the corresponding variety in human life, was that human beings could no longer be born in possession of full adult faculties. Infancy thus supervened as an accompaniment of increasing intellectuality. During infancy and youth the child *learns* what inheritance has not yet incorporated in its organization. Infancy, however, as a stage in individual life, is not confined to the human species. The man-like apes of Africa begin life as helpless babies, and are unable to walk, to feed themselves, or to grasp objects with precision until they are two or three months old. The difference between these and man is that the latter has a much increased cerebral surface, while the infancy of his progeny is correspondingly prolonged. Our earliest human ancestors lived, during an entire geologic æon, "a fierce and squalid existence." Yet even during that time was there progress; cerebral surface was increasing and babyhood was lengthening. "The process of evolution is excessively slow, and its ends are achieved at the cost of enormous waste of life"; still, for innumerable ages its direction has been toward the enriching, the diversifying, and the ennobling of human existence.

Discussing "the origins of society and morality," the exponent of the Darwinian theory tells us that "the psychical development of humanity since its earlier stages has been largely due to the reaction of individuals upon one another, in those various relations which we characterize as social." Infancy created the family, and the family, by taming, in a measure, individual selfishness, founded morality. The individual once brought under the law of the family, must begin to judge of his conduct by some standard outside of himself; "hence the germs of conscience and of the idea of duty." Society has thus led to a great improvement in the quality of individual life; it has made it possible for the world to have a Shakespeare, the difference between whose brain, taking creasing into account, and that of an Australian savage, "would doubtless be fifty times greater than the difference between the Australian's brain and that of an orang-outang." Such is the measure of our intellectual progress. On the moral side humanity can boast such leaders as Howard and Garrison. Yet the psychical development of man is not at an end. It is destined to go on, making not only intelligence greater, but sympathy stronger and more profound. It is true that the eliminating of strife "has gone on with the extreme slowness that marks all the world of evolution." Still, such a process is in operation, and upon it we build our hopes for the perfection of humanity.

So far the expounder of science. It will be observed that the statements he makes are either indisputable, or rest upon grounds of much apparent solidity. In connection with everything that he advances, there is an implicit appeal to verification. "If these things are not so," he seems to say, "then what are the facts?" It will be observed, also, that we are presented with no strained conclusions, with no glosses on

the text, with no doubtful or misleading metaphors, with no unwarranted suggestions. We have intelligible views, plainly and candidly expressed. The destiny of man is fairly considered in the light of his origin; but, as his origin occurred on earth, so in what precedes his "destiny" is discussed as a question of development and progress on the earth. It is modestly suggested, by no means dogmatically affirmed—the author herein agreeing with Mr. Spencer—that the influences that have raised mankind from brutehood to his present condition have not yet expended their force, but will carry him forward to further and indefinite developments of intelligence and morality.

Pass we now to consider the ideas presented, as it would almost seem, by a second Mr. Fiske, who undertakes the task of rendering innocuous or even edifying all that the first has put forward. Here we find what may perhaps best be described as a constant attempt to cut a larger garment than the cloth will allow. It is science that is supposed to supply the cloth, but, when science stints the measure, poetry and sentiment are laid under contribution. Much is done by way of suggestion, and points are so skillfully made that we need to be constantly on our guard lest we be led to mistake for knowledge what in reality is mere conjecture, or the expression of emotional longing.

But to proceed. In the preface we have a full admission that the question of a future life lies "outside the range of legitimate scientific discussion." At the same time it is maintained that we may have an "opinion" on the subject, and that our opinion on such a question "must necessarily be affected by the total mass of our opinions on the questions which lie within the scope of scientific inquiry." Here issue may be joined. If "the total mass of our opinions" on questions lying "within the scope of scientific inquiry" can guide us to an opinion on the question of a future life, then that question itself can not be said to lie "outside the range of legitimate scientific discussion." If, on the other hand, the laws and analogies which science reveals do *not* bear upon this question, then it is vain to talk of our conclusions thereon being affected by the total mass of our opinions, upon matters falling within the domain of science. In other words, there either is or is not a bridge between such questions as science commonly deals with and this question of immortality. If there is, let us walk over it and possess the farther land; if there is not, let us recognize the fact, and not pretend that the laws of the physical region throw any light on questions lying beyond that region. An "opinion" on such a matter, moreover, is not worth entertaining unless we can hope for some verification of it; and we only cheat ourselves by framing "opinions" and trying to think that in some remote way they have the sanction and support of science. It might also, with some show of reason, be maintained that mere opinions on such a point are likely to do a great deal of harm, since they are apt to stand in the way of the following out of a consistent line of thought and conduct. A man

who has merely an "opinion" is not bound by it one way or another. He may neglect the future life in the interest of the present, or the present in the alleged interest of the future, just as the inclination of the moment may lead him. The great works of the past were not wrought on the strength of an "opinion" in regard to this matter; nor will opinion lead to any great works in the present day. The work of the world in all ages has called for convictions, and it calls for them still. It is a somewhat singular thing that our author should have used the expression, "the total mass of our *opinions* on the questions which lie within the scope of scientific inquiry." The word "knowledge," I respectfully submit, was required in this place. It is our *knowledge* that can guide us to *opinions*, or, in other words, that can determine for us questions as to preponderance of evidence. An opinion that is based upon an opinion is too unsubstantial a thing to deserve any attention. The only advantage I can see in the use of the word "opinions" in the place indicated is, that it seems in a manner to help to bridge over the gap between the scientific and the non-scientific regions. The bridge, however, will not hold: it may be pretty to look at, but it has no firm anchorage.

As we have already seen, the Copernican theory destroyed the notion that man's abode, the earth, was the center of the universe. The very foundations of theology seemed at the time to have been shaken; but to-day "the speculative necessity for man's occupying the largest and most central spot in the universe is no longer felt." Upon this it may be observed that what disturbed our forefathers was not the conflict between the Copernican teaching and any speculative necessity of the period, but the conflict between that teaching and the plain declarations of the Scriptures. That was the trouble. Mr. Fiske tells us that the alarm was unnecessary—that the foundations of Christian theology have not really been shaken thereby. Possibly that is the best view to take of it, seeing that the matter can not be mended.

The reason why atheism is so abhorrent to us, why "we are wont to look upon it with unspeakable horror and loathing," is that "on its practical side it would remove humanity from its peculiar position in the world, and make it cast in its lot with the grass that withers and the beasts that perish." Can this statement, I ask, be soberly made by a man of science speaking in the name of science? In what sense does atheism—a form of belief with the truth or falsity of which we need not at present concern ourselves—remove humanity from any peculiar position distinctly, and on scientific grounds, shown to belong to it? The fact is, that if atheism went counter simply to any established tenet of science, it would excite not "unspeakable loathing and horror," but simply feelings of mingled amusement, pity, and contempt. There was unspeakable "horror and loathing" at Athens when it was found one morning that the statues of the god Hermes had been mutilated during the preceding night; but no such feelings

had stood in the way of the order given a few years earlier for the massacre of the whole male population of the flourishing city of Mytilene, or (though that order was rescinded *on grounds of policy*) of the putting to death in cold blood of one thousand Mytilenian prisoners! It is an unfortunate circumstance that "horror and loathing" have too generally been bestowed not upon atrocious crimes against humanity, but upon alleged offenses against the higher powers—in reality, upon affronts offered to theological opinion or prejudice.

The "peculiar position" of humanity is what it is, and neither atheism nor any other "ism" can make it other than it is. It is for us to discover, as far as may be, what our position is, and calmly to abide by our conclusions in the matter as long as they continue to recommend themselves to our reason. If we find that certain contrary views inspire us with "unspeakable horror and loathing" instead of with a sense of error and a desire to remove the error, we shall do well to examine ourselves as to whether we really be in the faith, whether we are not trying to atone by "horror and loathing" for indeterminateness of conviction and a deficient sense of intellectual wholeness and integrity. Such tempestuous emotions are not generally of good omen.

We can dispense, we are told, with the idea that our earth is the great cosmical center, because science now re-establishes our dignity by showing that the sun is but our Titan-like servant. Can it truly be said that science reveals this? I doubt very much that science establishes a servant-like relation of the sun to the earth. Poetry may do it; theology may try it as a *pis aller;* but science, unless my ignorance on such subjects is even greater than I take it to be, tells us no more than that the sun and the earth are parts of one system, fragments of one original nebula in different stages of evolution; and that, while the sun nourishes life upon our planet, it leaves the moon an arid waste; that, while it scorches Mercury with unbearable heat and shrouds it in almost impenetrable splendor, it sends to Uranus and Neptune but faintest pulses of light and warmth, not sufficient for any maintenance of life. Looking at the general arrangement of the solar system and the general action of terrestrial forces, it seems but trifling to pretend that human life is in any sense an explanation of the scheme as a whole, or that man's interests have been studied in any especial manner. Such a statement may seem to border on that doctrine which, as our author tells us, justly excites "unspeakable horror and loathing"; but, with all respect, I venture to express the contrary opinion, that it is a doctrine calculated to have a better moral effect than the one he labors to support. It is a doctrine which, while it tends to abate human egotism, tends also to increase our sense of responsibility. If our life is the grand culmination of creation, and if the creative power has special designs concerning us, our destinies are largely, if not wholly, taken out of our own hands. We become at once "a royal priesthood,

a peculiar people." Nothing henceforth is too good for us, no "waiting upon Providence" unjustifiable. If, on the other hand, we have no guarantee that we are in any special sense the nurslings of Heaven, then it rests with us to make the best of whatever endowments we find ourselves actually possessing. We dismiss conceit from our minds, and apply ourselves simply to know what is, in order that we may be able to exert the widest and most potent influence possible on our environment.

In further illustration of the superior dignity of our planet, it is observed that "that divine spark, the soul, as it takes up its brief abode in this realm of fleeting phenomena, chooses not the central sun where elemental forces forever blaze and clash, but selects an outlying terrestrial nook," etc. Admitting that the soul had a free choice in the matter, we must credit it with a good deal of sense in not betaking itself to a globe in which it could never by any possibility have found a body. But again, I ask, is this the voice of Science? No; it is the voice of the non-scientific and theological Mr. Fiske, who has undertaken to edit, much to the latter's hurt, the scientific Mr. Fiske. I really do not believe that the scientific Mr. Fiske knows anything about any exercise of choice by the soul as to what sphere it should inhabit. The latter simply knows that, under certain terrestrial conditions, what we commonly call "soul" manifests itself—no more.

A fine sentiment is uttered in the following passage: "To pursue unflinchingly the methods of science requires dauntless courage and a faith that nothing can shake. Such courage and such loyalty to Nature brings its own reward." Then what is the "own reward" of such admirable conduct? It is that we are enabled to see distinctly "for the first time how the creating and perfecting of man is the goal toward which Nature's work has all the while been tending." Here I must enter a respectful protest. I can not conceive that any special conclusion whatever, however edifying or comfortable, can be correctly spoken of as the natural (for that is the force here of "own") reward of loyalty to truth. If loyalty to truth brings *its own reward*, that reward can only consist in a confirmed habit of intellectual sincerity, and whatever of other moral excellence springs from such loyalty. Surely the strict scientific stand-point which our author promised to maintain has been badly deserted, when we are told that, if we are only loyal to truth, all our conclusions will come out in the most satisfactory shape. "Be loyal to truth," I should prefer to say, "and your reward will be that you will discover the truth in larger measure than you would otherwise do, and will have the signal advantage of being able to adapt your life to the truth instead of to fiction." That, in connection with strengthened moral character, seems to me to be the appropriate reward of loyalty to the truth, not the confirmation of any cherished theories. "The Darwinian theory," we are told, "makes it (human life) seem more than ever the chief object of that

creative activity which is manifested in the physical universe." But really from the scientific stand-point we are not much concerned with what things can be made to *seem*; we are concerned with what they can be proved to be. Opinion can not take the place of knowledge, nor yet of belief; and, in regard to all such questions, only knowledge and belief are of any avail. Prove to us that such and such things are so: well and good—our minds yield to evidence. Persuade us that they have been supernaturally revealed: well and good also—our minds take the desired set. But give us only probable opinions, the product of a kind of pseudo-scientific casuistry, and you do nothing for us at all, except perhaps diminish in some degree our sense for truth and reality.

The word "seem," above emphasized, may be said to furnish the key-note of the whole of what may be called the apologetic element in the work before us. The first Mr. Fiske tells us what things are, and how they have come to be what they are. The second tells us what they seem like to those who wish to think that the foundations of Christian theology have not been disturbed either by the Copernican astronomy or the Darwinian theory of the origin of species. The weakness of this kind of thing is that it may be worked in any direction and in any interest. Say what you want things to seem like, and they can easily be made to assume the desired complexion. Take an example. After animals have been devouring one another and starving one another out of existence for long ages, there appears an animal who assumes a predominance which he never afterward loses, and who goes on increasing his power and improving his position from century to century. Well, if one wishes to believe that the object toward which all this inter-mastication and inter-starvation of the myriad tribes of earth and air and sky was tending was the production of man, himself for long ages one of the most hideous of animals, there is no obstacle in the way except the complete lack of evidence in a positive sense plus the fact that the inter-mastication and inter-starvation are still going on now that man has come. If any one chooses to describe natural selection as a "simple and wasteful process," and then to say that it is "a slow and subtile" one, there is no obstacle in the way except the contrast which common sense establishes between simplicity and subtilty. If any one chooses to say that "the whole creation has been groaning and travailing together in order to bring forth that last consummate specimen of God's handiwork, the human soul," let him; for the phrase, if not scientific, is at least apostolic. Under the *régime* of "seems," a great deal can be done that is quite impossible under the unaccommodating rule of "is."

Take, for a moment, this expression of the creation "groaning and travailing together." What idea does it convey to which science gives the faintest confirmation? So far as we have any acquaintance with the facts, they are better expressed by the Lucretian idea of endless

combinations in endless series. There was groaning enough to be sure, by the way, but who can tell us, as a sober fact, that this groaning was an expression of Nature's effort to produce man, or that Nature is capable of any "effort," as we understand the word? Let us not mix up our poetry with our science. If we wish to think of Nature as groaning and travailing, we are at liberty to do so; but let us remember that in indulging such a conception we are poetizing, not adhering to scientific facts. "We are not dealing," says our author, "with vague general notions of development, but with the scientific Darwinian theory." All right, belay! Keep the sails just in that trim, and we shall get to some port of scientific truth, provided always the strict Darwinian theory is itself based on truth. As far as I am aware, Darwin himself had not caught sight, up to the time of his death, of any groaning and travailing of Nature over the work of producing the human soul.

There are a great many phrases and suggestions throughout the volume before us, besides those already noted, which might be quoted as showing the intention of the writer to make a kind of Darwinian philosophy *à l'usage des familles.* My space, however, is so nearly exhausted that I must pass over all but one of these. On page 117 we read that "the greatest philosopher of modern times, the master and teacher of all who shall study the process of evolution for many a day to come, holds that the conscious soul is not the product of a collocation of material particles, but is, in the deepest sense, a divine effluence." This I do not hesitate to say is a misrepresentation, involuntary, no doubt, of Mr. Spencer's position. If there is any meaning in language, it makes Mr. Spencer ascribe a special divinity to mind. Mr. Spencer, however, does nothing of the kind; he holds that there is one unknowable, unconditioned being, and that this manifests itself in the two conditioned forms of mind and matter. The material particles, therefore, can claim, according to his system of thought, just as much divinity of origin as the mind or soul itself. The word "divine," moreover, is not a word to the use of which Mr. Spencer is prone, and I could not readily turn to any passage in which he employs it to express any idea of his own. He speaks in his recent articles of "an Infinite and Eternal Energy"; but of the mind, in particular, as "a divine effluence," he does not speak. To say, therefore, so positively that Mr. Spencer regards the mind as "in the deepest sense a divine effluence," and that in distinction to the body, is not fair, to say the least, to the distinguished philosopher to the exposition of whose views Mr. Fiske has devoted his own most serious labors.

The conclusion of the whole matter appears to be this, that there is nothing to be gained by trying to read old theology into new science. It may be, as Mr. Fiske affirms, that the foundations of Christian theology have not been shaken—no one needs to be dogmatic on that point—but, as theology is a matter of revelation and science a matter

of observation, it is well to keep the two as separate as possible. The method of science is a gradual method: little by little, we widen the circle of our knowledge; little by little, we improve our hypotheses. Theology makes from the first the most comprehensive statements, and offers solutions of the profoundest problems. To apply, therefore, the dicta or the general conceptions of theology to the province of science is to run much risk of injuring the work of science by the forcing of premature conclusions; admitting that theology has nothing to teach that is positively erroneous. That loyalty to truth so fittingly referred to by our author requires us to content ourselves with such conclusions as we can reach by lawful and appropriate methods. If we see a law of natural selection at work, let us try to get as clear an understanding as possible of the manner of its working; but let us be very careful how we personify it, and how we impute to our personification feelings and purposes which correspond with nothing in the facts as we know them. Nothing could be more opposed to the human idea of "work" than the process of natural selection as described by our author himself, yet he constantly speaks of the "work" of natural selection. He tells us that "in the desperate struggle for existence no peculiarity has been too insignificant for natural selection to seize and enhance"; just as if natural selection were some vigilant intelligence watching for opportunities to advance its designs. The same fact which is thus expressed in, as I think, misleadingly metaphorical language could have been expressed in honest prose by saying that "in the desperate struggle for existence no peculiarity was too insignificant to contribute to survival *or destruction* as the case might be." There we have the fact without any illegitimate implications; and it is thus, as it strikes me, that scientific facts should be described. Species were formed, if the theory of natural selection is sound, in very much the same way in which the corners are ground off bowlders carried down by glaciers or swept away by torrents. Whatever projections happen to be in the way are knocked off; finally, the stone is reduced to a shape in which it is comparatively safe from further injury by friction. So with species. Darwin has discovered no law in nature by which good qualities (as such) are produced; he has simply discovered a law by which all kinds of qualities (differentiations), good, bad, and indifferent, are produced, and by which the bad ones (bad, i. e., in relation to the environment) are knocked off, like so many projecting angles, by the destruction of the individuals manifesting them. Mr. Fiske tells us that, for a long time past, so far as man is concerned, natural selection has been unable by itself to "rectify any particular unfitness." It never could rectify unfitness at any time; as Mr. Fiske tells us, on the very next page, "it always works by death." We might compare it to a physician who went about "rectifying" diseases by cutting the throats of his patients. Such drastic surgery might doubtless improve the aver-

age health of the community, but the process could scarcely be called curative or rectifying.

If, therefore, we believe in natural selection, let us believe in it as it is, and be content to speak of it as it is. *Let us not make a god of what is, in its essence, the very negation of intelligent action.* In regard to the doctrine of immortality, there is little need for alarm, so far as the teachings of science are concerned. Science does not attack it; and if the theological grounds on which it has been received hold good, then the doctrine holds good. Let us have our own teleology if we will, only let us not mix it up with our science, seeing that it can only embarrass the growth of the latter. All will be well if we keep everything in its own place, observing proper metes and bounds.

FOOD AND FEEDING.

By GRANT ALLEN.

WHEN a man and a bear meet together casually in an American forest, it makes a great deal of difference, to the two parties concerned at least, whether the bear eats the man or the man eats the bear. We haven't the slightest difficulty in deciding afterward which of the two, in each particular case, has been the eater, and which the eaten. Here, we say, is the grizzly that ate the man; or, here is the man that smoked and dined off the hams of the grizzly. Basing our opinion upon such familiar and well-known instances, we are apt to take it for granted far too readily that between eating and being eaten, between the active and the passive voice of the verb *edo*, there exists necessarily a profound and impassable native antithesis. To swallow an oyster is, in our own personal histories, so very different a thing from being swallowed by a shark that we can hardly realize at first the underlying fundamental identity of eating with mere coalescence. And yet, at the very outset of the art of feeding, when the nascent animal first began to indulge in this very essential animal practice, one may fairly say that no practical difference as yet existed between the creature that ate and the creature that was eaten. After the man and the bear had finished their little meal, if one may be frankly metaphorical, it was impossible to decide whether the remaining being was the man or the bear, or which of the two had swallowed the other. The dinner having been purely mutual, the resulting animal represented both the litigants equally; just as, in cannibal New Zealand, the chief who ate up his brother chief was held naturally to inherit the goods and chattels of the vanquished and absorbed rival, whom he had thus literally and physically incorporated.

A jelly-speck, floating about at his ease in a drop of stagnant

water under the field of a microscope, collides accidentally with another jelly-speck who happens to be traveling in the opposite direction across the same miniature ocean What thereupon occurs? One jelly-speck rolls itself gradually into the other, so that, instead of two, there is now one; and the united body proceeds to float away quite unconcernedly, without waiting to trouble itself for a second with the profound metaphysical question, which half of it is the original personality, and which half the devoured and digested. In these minute and very simple animals there is absolutely no division of labor between part and part; every bit of the jelly-like mass is alike head and foot and mouth and stomach. The jelly-speck has no permanent limbs, but it keeps putting forth vague arms and legs every now and then from one side or the other; and with these temporary and ever-dissolving members it crawls along merrily through its tiny drop of stagnant water. If two of the legs or arms happen to knock up casually against one another, they coalesce at once, just like two drops of water on a window-pane, or two strings of treacle slowly spreading along the surface of a plate. When the jelly-speck meets any edible thing—a bit of dead plant, a wee creature like itself, a microscopic egg—it proceeds to fold its own substance slimily around it, making, as it were, a temporary mouth for the purpose of swallowing it, and a temporary stomach for the purpose of quietly digesting and assimilating it afterward. Thus what at one moment is a foot may at the next moment become a mouth, and at the moment after that again a rudimentary stomach. The animal has no skin and no body, no outside and no inside, no distinction of parts or members, no individuality, no identity. Roll it up into one with another of its kind, and it couldn't tell you itself a minute afterward which of the two it had really been a minute before. The question of personal identity is here considerably mixed.

But as soon as we get to rather larger creatures of the same type, the antithesis between the eater and the eaten begins to assume a more definite character. The big jelly-bag approaches a good many smaller jelly-bags, microscopic plants, and other appropriate food-stuffs, and, surrounding them rapidly with its crawling arms, envelops them in its own substance, which closes behind them and gradually digests them. Everybody knows, by name at least, that revolutionary and evolutionary hero, the amœba—the terror of theologians, the pet of professors, and the insufferable bore of the general reader. Well, this parlous and subversive little animal consists of a comparatively large mass of soft jelly, pushing forth slender lobes, like threads or fingers, from its own substance, and gliding about, by means of these tiny legs, over water-plants and other submerged surfaces. But though it can literally turn itself inside out, like a glove, it still has some faint beginnings of a mouth and stomach, for it generally takes in food and absorbs water through a particular part of its surface, where the slimy mass of its body is thinnest. Thus the amœba may be said

really to eat and drink, though quite devoid of any special organs for eating or drinking.

The particular point to which I wish to draw attention here, however, is this: that even the very simplest and most primitive animals do discriminate somehow between what is eatable and what isn't. The amœba has no eyes, no nose, no mouth, no tongue, no nerves of taste, no special means of discrimination of any kind; and yet, so long as it meets only grains of sand or bits of shell, it makes no effort in any way to swallow them; but the moment it comes across a bit of material fit for its food, it begins at once to spread its clammy fingers around the nutritious morsel. The fact is, every part of the amœba's body apparently possesses, in a very vague form, the first beginnings of those senses which in us are specialized and confined to a single spot. And it is because of the light which the amœba thus incidentally casts upon the nature of the specialized senses in higher animals that I have ventured once more to drag out of the private life of his native pond that already too notorious and obtrusive rhizopod.

With us lordly human beings, at the extreme opposite end in the scale of being from the microscopic jelly-specks, the art of feeding and the mechanism which provides for it have both reached a very high state of advanced perfection. We have slowly evolved a tongue and palate on the one hand, and French cooks and *pâté de foie gras* on the other. But while everybody knows practically how things taste to us, and which things respectively we like and dislike, comparatively few people ever recognize that the sense of taste is not merely intended as a source of gratification, but serves a useful purpose in our bodily economy, in informing us what we ought to eat and what to refuse. Paradoxical as it may sound at first to most people, nice things are, in the main, things that are good for us, and nasty things are poisonous or otherwise injurious. That we often practically find the exact contrary the case (alas!) is due, not to the provisions of nature, but to the artificial surroundings in which we live, and to the cunning way in which we flavor up unwholesome food, so as to deceive and cajole the natural palate. Yet, after all, it is a pleasant gospel that what we like is really good for us, and, when we have made some small allowances for artificial conditions, it is in the main a true one also.

The sense of taste, which in the lowest animals is diffused equally over the whole frame, is in ourselves and other higher creatures concentrated in a special part of the body, namely, the mouth, where the food about to be swallowed is chewed and otherwise prepared beforehand for the work of digestion. Now, it is, of course, quite clear that some sort of supervision must be exercised by the body over the kind of food that is going to be put into it. Common experience teaches us that prussic acid and pure opium are undesirable food-stuffs in large quantities; that raw spirits, petroleum, and red lead should be spar-

ingly partaken of by the judicious feeder; and that even green fruit, the bitter end of cucumber, and the berries of deadly nightshade are unsatisfactory articles of diet when continuously persisted in. If, at the very outset of our digestive apparatus, we hadn't a sort of automatic premonitory adviser upon the kinds of food we ought or ought not to indulge in, we should naturally commit considerable imprudences in the way of eating and drinking—even more than we do at present. Natural selection has therefore provided us with a fairly efficient guide in this respect in the sense of taste, which is placed at the very threshold, as it were, of our digestive mechanism. It is the duty of taste to warn us against uneatable things, and to recommend to our favorable attention eatable and wholesome ones; and, on the whole, in the spite of small occasional remissness, it performs this duty with creditable success.

Taste, however, is not equally distributed over the whole surface of the tongue alike. There are three distinct regions or tracts, each of which has to perform its own special office and function. The tip of the tongue is concerned mainly with pungent and acrid tastes; the middle portion is sensitive chiefly to sweets and bitters; while the back or lower portion confines itself almost entirely to the flavors of roast meats, butter, oils, and other rich or fatty substances. There are very good reasons for this subdivision of faculties in the tongue, the object being, as it were, to make each piece of food undergo three separate examinations (like "smalls," "mods," and "greats" at Oxford), which must be successively passed before it is admitted into full participation in the human economy. The first examination, as we shall shortly see, gets rid at once of substances which would be actively and immediately destructive to the very tissues of the mouth and body; the second discriminates between poisonous and chemically harmless food-stuffs; and the third merely decides the minor question whether the particular food is likely to prove then and there wholesome or indigestible to the particular person. The sense of taste proceeds, in fact, upon the principle of gradual selection and elimination; it refuses first what is positively destructive, next what is more remotely deleterious, and finally what is only undesirable or over-luscious.

When we want to assure ourselves, by means of taste, about any unknown object—say a lump of some white stuff, which may be crystal, or glass, or alum, or borax, or quartz, or rock-salt—we put the tip of the tongue against it gingerly. If it begins to burn us, we draw it away more or less rapidly, with an accompaniment in language strictly dependent upon our personal habits and manners. The test we thus occasionally apply, even in the civilized adult state, to unknown bodies, is one that is being applied every day and all day long by children and savages. Unsophisticated humanity is constantly putting everything it sees up to its mouth in a frank spirit of experimental inquiry as to

its gustatory properties. In civilized life, we find everything ready labeled and assorted for us; we comparatively seldom require to roll the contents of a suspicious bottle (in very small quantities) doubtfully upon the tongue in order to discover whether it is pale sherry or Chili vinegar, Dublin stout or mushroom ketchup. But in the savage state, from which, geologically and biologically speaking, we have only just emerged, bottles and labels do not exist. Primitive man, therefore, in his sweet simplicity, has only two modes open before him for deciding whether the things he finds are or are not strictly edible. The first thing he does is to sniff at them, and smell being, as Mr. Herbert Spencer has well put it, an anticipatory taste, generally gives him some idea of what the thing is likely to prove. The second thing he does is to pop it into his mouth, and proceed practically to examine its further characteristics.

Strictly speaking, with the tip of the tongue one can't really taste at all. If you put a small drop of honey or of oil of bitter-almonds on that part of the mouth, you will find (no doubt to your great surprise) that it produces no effect of any sort; you only taste it when it begins slowly to diffuse itself, and reaches the true tasting region in the middle distance. But, if you put a little cayenne or mustard on the same part, you will find that it bites you immediately—the experiment should be tried sparingly—while if you put it lower down in the mouth you will swallow it almost without noticing the pungency of the stimulant. The reason is, that the tip of the tongue is supplied only with nerves which are really nerves of touch, not nerves of taste proper; they belong to a totally different main branch, and they go to a different center in the brain, together with the very similar threads which supply the nerves of smell for mustard and pepper. That is why the smell and taste of these pungent substances are so much alike, as everybody must have noticed; a good sniff at a mustard-pot producing almost the same irritating effects as an incautious mouthful. As a rule, we don't accurately distinguish, it is true, between these different regions of taste in the mouth in ordinary life; but that is because we usually roll our food about instinctively, without paying much attention to the particular part affected by it. Indeed, when one is trying deliberate experiments in the subject, in order to test the varying sensitiveness of the different parts to different substances, it is necessary to keep the tongue quite dry, in order to isolate the thing you are experimenting with, and prevent its spreading to all parts of the mouth together. In actual practice this result is obtained in a rather ludicrous manner—by blowing upon the tongue, between each experiment, with a pair of bellows. To such undignified expedients does the pursuit of science lead the ardent modern psychologist. Those domestic rivals of Dr. Forbes Winslow, the servants, who behold the enthusiastic investigator alternately drying his tongue in this ridiculous fashion, as if he were a blacksmith's fire, and then squeezing out a single drop of

essence of pepper, vinegar, or beef-tea from a glass syringe upon the dry surface, not unnaturally arrive at the conclusion that master has gone stark-mad, and that, in their private opinion, it's the microscope and the skeleton as has done it.

Above all things, we don't want to be flayed alive. So the kinds of tastes discriminated by the tip of the tongue are the pungent, like pepper, cayenne, and mustard; the astringent, like borax and alum; the alkaline, like soda and potash; the acid, like vinegar and green fruit; and the saline, like salt and ammonia. Almost all the bodies likely to give rise to such tastes (or, more correctly, sensations of touch in the tongue) are obviously unwholesome and destructive in their character, at least when taken in large quantities. Nobody wishes to drink nitric acid by the quart. The first business of this part of the tongue is, therefore, to warn us emphatically against caustic substances and corrosive acids—against vitriol and kerosene, spirits of wine and ether, capsicums and burning leaves or roots, such as those of the common English lords-and-ladies. Things of this sort are immediately destructive to the very tissues of the tongue and palate; if taken incautiously in too large doses, they burn the skin off the roof of the mouth; and when swallowed they play havoc, of course, with our internal arrangements. It is highly advisable, therefore, to have an immediate warning of these extremely dangerous substances, at the very outset of our feeding apparatus.

This kind of taste hardly differs from touch or burning. The sensibility of the tip of the tongue is only a very slight modification of the sensibility possessed by the skin generally, and especially by the inner folds over all delicate parts of the body. We all know that common caustic burns us wherever it touches; and it burns the tongue, only in a somewhat more marked manner. Nitric or sulphuric acid attacks the fingers each after its own kind. A mustard-plaster makes us tingle almost immediately; and the action of mustard on the tongue hardly differs, except in being more instantaneous and more discriminative. Cantharides work in just the same way. If you cut a red pepper in two and rub it on your neck it will sting just as it does when put into soup (this experiment, however, is best tried upon one's younger brother; if made personally, it hardly repays the trouble and annoyance). Even vinegar and other acids, rubbed into the skin, are followed by a slight tingling; while the effect of brandy, applied, say, to the arms, is gently stimulating and pleasurable, somewhat in the same way as when normally swallowed in conjunction with the habitual seltzer. In short, most things which give rise to distinct tastes when applied to the tip of the tongue give rise to fainter sensations when applied to the skin generally. And one hardly needs to be reminded that pepper or vinegar placed (accidentally as a rule) on the inner surface of the eyelids produces a very distinct and unpleasant smart.

The fact is, the liability to be chemically affected by pungent or

acid bodies is common to every part of the skin; but it is least felt where the tough outer skin is thickest, and most felt where that skin is thinnest and the nerves are most plentifully distributed near the surface. A mustard-plaster would probably fail to draw at all on one's heel or the palm of one's hand, while it is decidedly painful on one's neck or chest; and a mere speck of mustard inside the eyelid gives one positive torture for hours together. Now, the tip of the tongue is just a part of one's body specially set aside for this very object, provided with an extremely thin skin, and supplied with an immense number of nerves, on purpose so as to be easily affected by all such pungent, alkaline, or spirituous substances. Sir Wilfrid Lawson would probably conclude that it was deliberately designed by Providence to warn us against a wicked indulgence in the brandy and seltzer aforesaid.

At first sight it might seem as though there were hardly enough of such pungent and fiery things in existence to make it worth while for us to be provided with a special mechanism for guarding against them. That is true enough, no doubt, as regards our modern civilized life; though, even now, it is perhaps just as well that our children should have an internal monitor (other than conscience) to dissuade them immediately from indiscriminate indulgence in photographic chemicals, the contents of stray medicine-bottles, and the best dried West India chilies. But in an earlier period of progress, and specially in tropical countries (where the Darwinians have now decided the human race made its first *début* upon this or any other stage), things were very different indeed. Pungent and poisonous plants and fruits abounded on every side. We have all of us in our youth been taken in by some too cruelly waggish companion, who insisted upon making us eat the bright, glossy leaves of the common English arum, which without look pretty and juicy enough, but within are full of the concentrated essence of pungency and profanity. Well, there are hundreds of such plants, even in cold climates, to tempt the eyes and poison the veins of unsuspecting cattle or childish humanity. There is buttercup, so horribly acrid that cows carefully avoid it in their closest-cropped pastures; and yet your cow is not usually a too dainty animal. There is aconite, the deadly poison with which Dr. Lamson removed his troublesome relatives. There is baneberry, whose very name sufficiently describes its dangerous nature. There are horse-radish, and stinging rocket, and biting wall-pepper, and still smarter water-pepper, and wormwood, and nightshade, and spurge, and hemlock, and half a dozen other equally unpleasant weeds. All of these have acquired their pungent and poisonous properties, just as nettles have acquired their sting, and thistles their thorns, in order to prevent animals from browsing upon them and destroying them. And the animals in turn have acquired a very delicate sense of pungency on purpose to warn them beforehand of the existence of such dangerous and undesirable qualities

in the plants which they might otherwise be tempted incautiously to swallow.

In tropical woods, where our "hairy quadrumanous ancestor" (Darwinian for the primeval monkey, from whom we are presumably descended) used playfully to disport himself, as yet unconscious of his glorious destiny as the remote progenitor of Shakespeare, Milton, and the late Mr. Peace—in tropical woods, such acrid or pungent fruits and plants are particularly common, and correspondingly annoying. The fact is, our primitive forefather and all the other monkeys are, or were, confirmed fruit-eaters. But to guard against their depredations a vast number of tropical fruits and nuts have acquired disagreeable or fiery rinds and shells, which suffice to deter the bold aggressor. It may not be nice to get your tongue burned with a root or fruit, but it is at least a great deal better than getting poisoned; and, roughly speaking, pungency in external nature exactly answers to the rough, gaudy labels which some chemists paste on bottles containing poisons. It means to say, "This fruit or leaf, if you eat it in any quantities, will kill you." That is the true explanation of capsicums, pimento, colocynth, croton-oil, the upas-tree, and the vast majority of bitter, acrid, or fiery fruits and leaves. If we had to pick up our own livelihood, as our naked ancestors had to do, from roots, seeds, and berries, we should far more readily appreciate this simple truth. We should know that a great many more plants than we now suspect are bitter or pungent, and therefore poisonous. Even in England we are familiar enough with such defenses as those possessed by the outer rind of the walnut; but the tropical cashew-nut has a rind so intensely acrid that it blisters the lips and fingers instantaneously, in the same way as cantharides would do. I believe that, on the whole, taking Nature throughout, more fruits and nuts are poisonous, or intensely bitter, or very fiery, than are sweet, luscious, and edible.

"But," says that fidgety person, the hypothetical objector (whom one always sets up for the express purpose of promptly knocking him down again), "if it be the business of the fore part of the tongue to warn us against pungent and acrid substances, how comes it that we purposely use such things as mustard, pepper, curry-powder, and vinegar?" Well, in themselves all these things are, strictly speaking, bad for us; but in small quantities they act as agreeable stimulants; and we take care in preparing most of them to get rid of the most objectionable properties. Moreover, we use them, not as foods, but merely as condiments. One drop of oil of capsicums is enough to kill a man, if taken undiluted; but in actual practice we buy it in such a very diluted form that comparatively little harm arises from using it. Still, very young children dislike all these violent stimulants, even in small quantities; they won't touch mustard, pepper, or vinegar, and they recoil at once from wine or spirits. It is only by slow degrees that we learn these unnatural tastes, as our nerves get blunted and our palates jaded; and

we all know that the old Indian who can eat nothing but dry curries, deviled biscuits, anchovy paste, pepper-pot, mulligatawny soup, Worcestershire sauce, preserved ginger, hot pickles, fiery sherry, and neat cognac, is also a person with no digestion, a fragmentary liver, and very little chance of getting himself accepted by any safe and solvent insurance office. Throughout, the warning in itself is a useful one; it is we who foolishly and persistently disregard it. Alcohol, for example, tells us at once that it is bad for us; yet we manage so to dress it up with flavoring matters and dilute it with water that we overlook the fiery character of the spirit itself. But that alcohol is in itself a bad thing (when freely indulged in) has been so abundantly demonstrated in the history of mankind that it hardly needs any further proof.

The middle region of the tongue is the part with which we experience sensations of taste proper—that is to say, of sweetness and bitterness. In a healthy, natural state all sweet things are pleasant to us, and all bitters (even if combined with sherry) unpleasant. The reason for this is easy enough to understand. It carries us back at once into those primeval tropical forests where our "hairy ancestor" used to diet himself upon the fruits of the earth in due season. Now, almost all edible fruits, roots, and tubers contain sugar; and therefore the presence of sugar is, in the wild condition, as good a rough test of whether anything is good to eat as one could easily find. In fact, the argument cuts both ways: edible fruits are sweet because they are intended for man and other animals to eat; and man and other animals have a tongue pleasurably affected by sugar because sugary things in nature are for them in the highest degree edible. Our early progenitors formed their taste upon oranges, mangoes, bananas, and grapes; upon sweet-potatoes, sugar-cane, dates, and wild honey. There is scarcely anything fitted for human food in the vegetable world (and our earliest ancestors were most undoubted vegetarians) which does not contain sugar in considerable quantities. In temperate climates (where man is but a recent intruder), we have taken, it is true, to regarding wheaten bread as the staff of life; but in our native tropics enormous populations still live almost exclusively upon plantains, bananas, bread-fruit, yams, sweet-potatoes, dates, cocoanuts, melons, cassava, pineapples, and figs. Our nerves have been adapted to the circumstances of our early life as a race in tropical forests; and we still retain a marked liking for sweets of every sort. Not content with our strawberries, raspberries, gooseberries, currants, apples, pears, cherries, plums, and other northern fruits, we ransack the world for dates, figs, raisins, and oranges. Indeed, in spite of our acquired meat-eating propensities, it may be fairly said that fruits and seeds (including wheat, rice, peas, beans, and other grains and pulse) still form by far the most important element in the food-stuffs of human populations generally.

But, besides the natural sweets, we have also taken to producing artificial ones. Has any housewife ever realized the alarming condition of cookery in the benighted generations before the invention of sugar? It is really almost too appalling to think about. So many things that we now look upon as all but necessaries—cakes, puddings, made dishes, confectionery, preserves, sweet biscuits, jellies, cooked fruits, tarts, and so forth—were then practically quite impossible. Fancy attempting nowadays to live a single day without sugar; no tea, no coffee, no jam, no pudding, no cake, no sweets, no hot toddy before one goes to bed; the bare idea of it is too terrible! And yet that was really the abject condition of all the civilized world up to the middle of the middle ages. Horace's punch was sugarless and lemonless; the gentle Virgil never tasted the congenial cup of afternoon tea; and Socrates went from his cradle to his grave without ever knowing the flavor of peppermint bull's-eyes. How the children managed to spend their Saturday *as*, or their weekly *obolus*, is a profound mystery. To be sure, people had honey; but honey is rare, dear, and scanty; it can never have filled one quarter the place that sugar fills in our modern affections. Try for a moment to realize drinking honey with one's whisky-and-water, or doing the year's preserving with a pot of best Narbonne, and you get at once a common measure of the difference between the two as practical sweeteners. Nowadays, we get sugar from cane and beet-root in abundance, while sugar-maples and palm-trees of various sorts afford a considerable supply to remoter countries. But the childhood of the little Greeks and Romans must have been absolutely unlighted by a single ray of joy from chocolate cream or Everton taffy.

The consequence of this excessive production of sweets in modern times is, of course, that we have begun to distrust the indications afforded us by the sense of taste in this particular as to the wholesomeness of various objects. We can mix sugar with anything we like, whether it had sugar in it to begin with or otherwise; and by sweetening and flavoring we can give a false palatableness to even the worst and most indigestible rubbish, such as plaster-of-Paris, largely sold under the name of sugared almonds to the ingenuous youth of two hemispheres. But in untouched nature the test rarely or never fails. As long as fruits are unripe and unfit for human food, they are green and sour; as soon as they ripen they become soft and sweet, and usually acquire some bright color as a sort of advertisement of their edibility. In the main, bar the accidents of civilization, whatever is sweet is good to eat—nay more, is meant to be eaten; it is only our own perverse folly that makes us sometimes think all nice things bad for us, and all wholesome things nasty. In a state of nature, the exact opposite is really the case. One may observe, too, that children, who are literally young savages in more senses than one, stand nearer to the primitive feeling in this respect than grown-up people. They

unaffectedly like sweets; adults, who have grown more accustomed to the artificial meat diet, don't, as a rule, care much for puddings, cakes, and made dishes. (May I venture parenthetically to add, any appearance to the contrary notwithstanding, that I am not a vegetarian, and that I am far from desiring to bring down upon my devoted head the imprecation pronounced against the rash person who would rob a poor man of his beer. It is quite possible to believe that vegetarianism was the starting-point of the race, without wishing to consider it also as the goal; just as it is quite possible to regard clothes as purely artificial products of civilization, without desiring personally to return to the charming simplicity of the garden of Eden.)

Bitter things in nature at large, on the contrary, are almost invariably poisonous. Strychnia, for example, is intensely bitter, and it is well known that life can not be supported on strychnia alone for more than a few hours. Again, colocynth and aloes are far from being wholesome food-stuffs, for a continuance; and the bitter end of cucumber does not conduce to the highest standard of good living. The bitter matter in decaying apples is highly injurious when swallowed, which it isn't likely to be by anybody who ever tastes it. Wormwood and walnut-shells contain other bitter and poisonous principles; absinthe, which is made from one of them, is a favorite slow poison with the fashionable young men of Paris, who wish to escape prematurely from "*le monde où l'on s'ennuie.*" But prussic acid is the commonest component in all natural bitters, being found in bitter-almonds, apple-pippins, the kernels of mango-stones, and many other seeds and fruits. Indeed, one may say roughly that the object of Nature generally is to prevent the actual seeds of edible fruits from being eaten and digested; and for this purpose, while she stores the pulp with sweet juices, she incloses the seed itself in hard, stony coverings, and makes it nasty with bitter essences. Eat an orange-pip, and you will promptly observe how effectual is this arrangement. As a rule, the outer rind of nuts is bitter, and the inner kernel of edible fruits. The tongue thus warns us immediately against bitter things, as being poisonous, and prevents us, automatically, from swallowing them.

"But how is it," asks our objector again, "that so many poisons are tasteless, or even, like sugar of lead, pleasant to the palate?" The answer is (you see, we knock him down again, as usual) because these poisons are themselves for the most part artificial products; they do not occur in a state of nature, at least in man's ordinary surroundings. Almost every poisonous thing that we are really liable to meet with in the wild state we are warned against at once by the sense of taste; but of course it would be absurd to suppose that natural selection could have produced a mode of warning us against poisons which have never before occurred in human experience. One might just as well expect that it should have rendered us dynamite-proof, or have

given us a skin like the hide of a rhinoceros to protect us against the future contingency of the invention of rifles.

Sweets and bitters are really almost the only tastes proper, almost the only ones discriminated by this central and truly gustatory region of the tongue and palate. Most so-called flavorings will be found on strict examination to be nothing more than mixtures with these of certain smells or else of pungent, salty, or alkaline matters, distinguished as such by the tip of the tongue. For instance, paradoxical as it sounds to say so, cinnamon has really no taste at all, but only a smell. Nobody will ever believe this on first hearing, but nothing on earth is easier than to put it to the test. Take a small piece of cinnamon, hold your nose tightly, rather high up, between the thumb and finger, and begin chewing it. You will find that it is absolutely tasteless; you are merely chewing a perfectly insipid bit of bark. Then let go your nose, and you will find immediately that it "tastes" strongly, though in reality it is only the perfume from it that you now permit to rise into the smelling-chamber in the nose. So, again, cloves have only a pungent taste and a peculiar smell, and the same is the case more or less with almost all distinctive flavorings. When you come to find of what they are made up, they consist generally of sweets or bitters, intermixed with certain ethereal perfumes, or with pungent or acid tastes, or with both or several such together. In this way, a comparatively small number of original elements, variously combined, suffice to make up the whole enormous mass of recognizably different tastes and flavors.

The third and lowest part of the tongue and throat is the seat of those peculiar tastes to which Professor Bain, the great authority upon this important philosophical subject, has given the names of relishes and disgusts. It is here, chiefly, that we taste animal food, fats, butters, oils, and the richer class of vegetables and made dishes. If we like them, we experience a sensation which may be called a relish, and which induces one to keep rolling the morsel farther down the throat, till it passes at last beyond the region of our voluntary control. If we don't like them, we get the sensation which may be called a disgust, and which is very different from the mere unpleasantness of excessively pungent or bitter things. It is far less of an intellectual and far more of a physical and emotional feeling. We say, and say rightly, of such things that we find it hard to swallow them; a something within us (of a very tangible nature) seems to rise up bodily and protest against them. As a very good example of this experience, take one's first attempt to swallow cod-liver oil. Other things may be unpleasant or unpalatable, but things of this class are in the strictest sense nasty and disgusting.

The fact is, the lower part of the tongue is supplied with nerves in close sympathy with the digestion. If the food which has been passed by the two previous examiners is found here to be simple and

digestible, it is permitted to go on unchallenged; if it is found to be too rich, too bilious, or too indigestible, a protest is promptly entered against it, and if we are wise we will immediately desist from eating any more of it. It is here that the impartial tribunal of nature pronounces definitely against roast goose, mince-pies, *pâté de foie gras*, sally lunn, muffins and crumpets, and creamy puddings. It is here, too, that the slightest taint in meat, milk, or butter is immediately detected; that rancid pastry from the pastrycook's is ruthlessly exposed, and that the wiles of the fishmonger are set at naught by the judicious palate. It is the special duty, in fact, of this last examiner to discover, not whether food is positively destructive, not whether it is poisonous or deleterious in nature, but merely whether it is then and there digestible or undesirable.

As our state of health varies greatly from time to time, however, so do the warnings of this last sympathetic adviser change and flicker. Sweet things are always sweet, and bitter things always bitter; vinegar is always sour, and ginger always hot in the mouth, too, whatever our state of health or feeling; but our taste for roast loin of mutton, high game, salmon cutlets, and Gorgonzola cheese varies immensely from time to time, with the passing condition of our health and digestion. In illness, and especially in sea-sickness, one gets the distaste carried to the extreme; you may eat grapes or suck an orange in the chops of the Channel, but you do not feel warmly attached to the steward who offers you a basin of greasy ox-tail, or consoles you with promises of ham-sandwiches in half a minute. Under those too painful conditions it is the very light, fresh, and stimulating things that one can most easily swallow—champagne, soda-water, strawberries, peaches, not lobster salad, sardines on toast, green Chartreuse, or hot brandy-and-water. On the other hand, in robust health, and when hungry with exercise, you can eat fat pork with relish on a Scotch hill-side, or dine off fresh salmon three days running without inconvenience. Even a Spanish stew, with plenty of garlic in it, and floating in olive-oil, tastes positively delicious after a day's mountaineering in the Pyrenees.

The healthy popular belief, still surviving in spite of cookery, that our likes and dislikes are the best guide to what is good for us, finds its justification in this fact, that whatever is relished will prove on the average wholesome, and whatever rouses disgust will prove on the whole indigestible. Nothing can be more wrong, for example, than to make children eat fat when they don't want it. A healthy child likes fat, and eats as much of it as he can get. If a child shows signs of disgust at fat, that proves that it is of a bilious temperament, and it ought never to be forced into eating it against its will. Most of us are bilious in after-life just because we were compelled to eat rich food in childhood, which we felt instinctively was unsuitable for us. We might still be indulging with impunity in thick turtle, canvas-back

ducks, deviled whitebait, meringues, and Nesselrode puddings, if we hadn't been so persistently overdosed in our earlier years with things that we didn't want and knew were indigestible.

Of course, in our existing modern cookery, very few simple and uncompounded tastes are still left to us; everything is so mixed up together that only by an effort of deliberate experiment can one discover what are the special effects of special tastes upon the tongue and palate. Salt is mixed with almost everything we eat—*sal sapit omnia*—and pepper or cayenne is nearly equally common. Butter is put into the peas, which have been previously adulterated by being boiled with mint; and cucumber is unknown except in conjunction with oil and vinegar. This makes it comparatively difficult for us to realize the distinctness of the elements which go to make up most tastes as we actually experience them. Moreover, a great many eatable objects have hardly any taste of their own, properly speaking, but only a feeling of softness or hardness, or glutinousness in the mouth, mainly observed in the act of chewing them. For example, plain boiled rice is almost wholly insipid; but even in its plainest form salt has usually been boiled with it, and in practice we generally eat it with sugar, preserves, curry, or some other strongly flavored condiment. Again, plain boiled tapioca and sago (in water) are as nearly tasteless as anything can be; they merely yield a feeling of gumminess; but milk, in which they are oftenest cooked, gives them a relish (in the sense here restricted), and sugar, eggs, cinnamon, or nutmeg are usually added by way of flavoring. Even turbot has hardly any taste proper, except in the glutinous skin, which has a faint relish; the epicure values it rather because of its softness, its delicacy, and its light flesh. Gelatine by itself is merely very swallowable—we must mix sugar, wine, lemon-juice, and other flavorings in order to make it into good jelly. Salt, spices, essences, vanilla, vinegar, pickles, capers, ketchups, sauces, chutneys, lime-juice, curry, and all the rest, are just our civilized expedients for adding the pleasure of pungency and acidity to naturally insipid foods, by stimulating the nerves of touch in the tongue, just as sugar is our tribute to the pure gustatory sense, and oil, butter, bacon, lard, and the various fats used in frying to the sense of relish which forms the last element in our compound taste. A boiled sole is all very well when one is just convalescent, but in robust health we demand the delights of egg and bread-crumb, which are after all only the vehicle for the appetizing grease. Plain boiled macaroni may pass muster in the unsophisticated nursery, but in the pampered dining-room it requires the aid of toasted parmesan. Good modern cookery is the practical result of centuries of experience in this direction; the final flower of ages of evolution, devoted to the equalization of flavors in all human food. Think of the generations of fruitless experiment that must have passed before mankind discovered that mint-sauce (itself a cunning compound of vinegar and sugar) ought to

be eaten with leg of lamb, that roast goose required a corrective in the shape of apple, and that while a pre-established harmony existed between salmon and lobster, oysters were ordained beforehand by Nature as the proper accompaniment of boiled cod! Whenever I reflect upon such things, I become at once a good Positivist, and offer up praise in my own private chapel to the Spirit of Humanity which has slowly perfected these profound rules of good living.—*Cornhill Magazine.*

SULPHUR AND ITS EXTRACTION.

By C. G. WARNFORD LOCK.

THE following notes relate exclusively to native sulphur (brimstone). Though the amount of sulphur annually mined in the form of sulphides of various metals (e. g., iron and copper pyrites, galena, blende, etc.) probably far exceeds that obtained in the uncombined state, still, the separation of the sulphur in an inoxidized condition from such compounds is never attempted, for the simple reasons that, in the processes for extracting the several metals from their ores, the first step necessary is the elimination of the combined sulphur, which is most easily effected by a roasting or oxidizing operation, whereby the sulphur is at once converted into sulphurous acid, itself a valuable commodity, and, moreover, capable of being readily oxidized one step further to form sulphuric acid, the chief purpose for which sulphur is consumed.

There are two mines of sulphur worked in Austria-Hungary, one not far from Cracow, and the other at Radoboi in Croatia; both deposits are of considerable extent, but the annual yield is insignificant. The whole district around Mount Büdös, in Transylvania, is rich in sulphur. Some thirty or more diggings have been undertaken in a circuit of eighteen miles, but the area covered by the deposits is more than three times this size. The sulphur occurs in unequal strata one to nine inches thick, beneath one to three feet of mold. The soil is everywhere saturated with sulphur, and in this permeated earth pieces of the pure mineral are found. The whole is the result of living solfataric action, and the accumulation will continue to grow as long as that action survives. Samples of the impregnated earth, taken over an area of 16,000,000 square fathoms, yielded from forty-one to sixty-four per cent of sulphur. Allowing for interruptions in the deposits, and taking these at an average thickness of three inches instead of nine, the total sulphur output of the Austrian Empire, in 1863, was 1,754 tons, at an average rate of £12 15*s.* per ton. The imports are about five thousand tons per annum.

Large quantities of sulphur are found in and about the crater of

Gunong Api, in the Banda Islands, and attempts have been made to collect it for exportation. It is said, however, that the labor of ascending the mountain is too great to render the speculation profitable.

Sulphur is one of the most important products of Formosa. When taken from the mine, the ore is boiled in iron pans till it assumes a treacly consistence. This is constantly stirred till every impurity is separated from the sulphur, which is then ladled out into wooden tubs, shaped like sugar-loaves. In these it is left to cool, and the conical cakes are freed from the tubs by the simple process of knocking out the bottoms of the latter.

Sulphur is procurable in salable quantities from the mountains around Ta-chien-la, in Western China; the inhabitants of the ravines may often be seen engaged in the manufacture of matches of the Guy Fawkes pattern, which they split from a pine plank with a spokeshave, and tip with sulphur. During his penniless residence at Na-erh-pa, Baber generally used these sulphur chips to procure a flame.

Near the hamlet of Tappets, about three miles northeast of Apt, in the department of Vaucluse, France, is a bed of sulphur-ore yielding about twenty to twenty-five per cent. It consists of a sulphur-impregnated, marly limestone, and accompanies the lignite-beds of the tertiary system. The deposit is neither very extensive nor very thick.

The sulphur-deposits of Krisuvik, in the south of Iceland, belong to the recent solfataric group, and, though often compared with the Sicilian mines, bear very little analogy to them. The sulphur occurs in a fine state, intimately associated with earthy impurities, as a superficial layer of no great depth, but having recuperative powers that render them practically inexhaustible. They are now the property of an English company, and give promise of being worked to advantage in the future.

The sulphur-deposits of India, according to Professor V. Ball,* are unimportant, and inconveniently situated. Near a village called Sura-Sany-Yanam, between the mouths of the Godaveri, in Madras, small heaps of sulphur are occasionally collected in the dried-up margin of a tidal swamp, where the mineral appears to result from deoxidation of gypsum by contact with organic matter. Another trifling deposit is reported to occur at Ghizri Bandar, near Karachi. A considerable mine, worked by adits and chambers, exists at Sunnee in Cutchi, Beloochistan, and affords the chief supply for Candahar. Sulphur is obtained in some abundance from near a hot spring called Pir Zinda, in the Soree Pass of the Suleiman Hills, Afghanistan. A "vast quantity" of sulphur is said to occur at Hazara, North Afghanistan. On the southern flanks of the Gunjully Hills, in the Kohat district of the Punjaub, a large amount of sulphur is constantly being deposited as a result of the decomposition of pyritiferous alum-shales. As much

* "Economic Geology of India."

as one thousand tons a year is said to have been gathered. At Luni-ki-Kussi, on the west side of the Indus, sulphur is obtained by roasting the loose earth. The sulphur-mines at Nakband (Kushalgarh), on the Indus, eight miles from the mouth of the Kohat, are thirty to forty feet deep, and have yielded largely, the ore being sublimed as in Beloochistan.

The sulphur at Puga, in Kashmir, occurs massive, and as a lining in the clefts and fissures of a sort of quartz schist, often accompanied by gypsum. The process of formation seems to be still at work, judging by hot springs in the neighborhood. The deposits are worked by pits about eight feet deep, and adits of the same length; but the production is small. A trifling quantity of sulphur is deposited by hot springs in the beds of the Ramgunga and Garjia Rivers, in the Kumaun district of the Northwest Provinces; and a considerable amount is found in the galleries of the lead-mines at Meywar, on the Tons River, in the Jaunsar district. Little is known of the Nepaulese sulphur mines. In upper Burmah are several localities.

The sulphur-deposits of the Italian Romagna are situated in the Miocene lacustrine formation, and lie amid the sub-Apennine hills. The mines worked in the province of Forli, by the Cesena Sulphur Company, cover an area of about two hundred and sixty square kilometres. Their average annual production for the seven years 1873–'79 was 27,789 tons. The cost of extraction, refining, and royalties come to about four pounds per ton, according to Consul Colnaghi. The mineral is worked by blasting, each miner having to bore three holes in six hours, when all are fired simultaneously. At Pergola, some sixty kilometres distant from Ancona, is a sulphur-mine worked by a German company, which shipped ninety tons of refined sulphur to England in 1880. In Central Italy, near Bologna, a vein is worked which extends over fifteen miles in length. The ore is poor, and has to be raised from a considerable depth.

Sulphur is said to be abundant in the Japanese island of Yezo.

A good deal of sulphur is collected at Camiguin, in the Philippine Islands.

In Sicily, at the end of the Middle Miocene period, the sulphur-bearing area was raised, and lakes were formed in which occurred the deposition of the sulphur-rock and its accompanying gypsum, tripoli, and silicious limestone. The sulphur-rock is composed of sulphur and marly limestone, the sulphur being sometimes disseminated through the limestone, and at others forming thin alternate layers with it. These sulphur-bearing seams are often separated by layers of black marl, twenty inches to six feet thick, some seams attaining a thickness of twenty-eight feet. The total aggregate thickness of the sulphur-seams reaches one hundred feet in one case, but the average total is ten to twelve feet only. All the seams are decomposed at their outcrop, and show only an accumulation of whitish friable earth, called *bris-*

cale by the miners, and mainly composed of gypsum. This has resulted from the oxidation of the sulphur to sulphuric acid by atmospheric agency, the acid in turn attacking the lime carbonate, and forming sulphate (gypsum). The most plausible supposition as to the origin of the sulphur-seams would appear to be that the lakes received streams of water containing calcium sulphide in solution, this calcium sulphide probably resulting from a reduction of the masses of calcium sulphate (gypsum) by the action of volcanic heat. Gradual decomposition of the calcium sulphide in the presence of water would finally result in a deposition of sulphur and of lime carbonate, in the relative proportions of twenty-four and seventy-six per cent. As a matter of fact, much of the Sicilian ore actually has this percentage composition. Whatever the process has been, it is no longer in activity, and there is no growth nor renewal of the beds, in this respect differing essentially from recent deposits due to "living" solfataric action.

Almost all the Sicilian ore is carried to the surface on boys' backs, consequently it does not pay to work below about four hundred feet, as it then becomes necessary to employ hauling machinery. Hence the deposits lying below that horizon are hardly touched, and as many of the beds are nearly vertical, and do not diminish in yield as they descend, the still untouched resources must be very great. Various estimates have been made as to the period for which the supply will last at the present rate of consumption ; these range from fifty to two hundred years. There are said to be about two hundred and fifty mines in the island, and no less than 4,367 *calcaroni* were reported in operation fifteen years ago. The average yield is stated not to exceed fourteen per cent.

In the province of Murcia, and at other places, in Spain, the existence of fine beds of sulphur has been ascertained. One is worked by an English association, the Hellin Sulphur Company. The quality is very good.

A sulphur-deposit exists at Djemsa, in a perfectly rainless desert on the African coast near Suez, very near the sea, and constituting a hill six hundred feet high, whose sides are blasted down as in quarrying stone. Some two hundred Arabs, employed under French engineers, succeeded in mining ten tons a day. A similar deposit occurs at Ranga, five hundred miles from Suez, also near the coast of the African Continent, which differs only in being buried under other strata, so that mining is necessary.

The Gunong Jollo, or sulphur mountain of the Sunda Islands, lies southwest of the village Prado, and southeast of Dompo. The sulphur is dug from three places in an old crater now in the solfataric stage of its existence. Each spot is one hundred to one hundred and twenty roods long, and fifty to sixty broad. The sulphur collects between masses of white stone (perhaps decomposed trachyte), and sometimes covers a space of one to three roods square. On the liquid and warm

sulphur a hard crust forms, two inches thick. Digging is only carried on at morning and evening, the heat being too great at midday. Round holes are made, eight to nine feet apart, two feet deep, and with an outlet from above of one foot, and from below of three or four feet. Sulphur is also found in the solfatara of Gunong Prewa, but in trifling quantity. A great deal exists on the sides of Tambora.

Tripoli possesses a sulphur-deposit important both for extent and richness, but it is not worked.

In Turkey, native sulphur is found in some quantity adjacent to the lead lodes at Devrent (Derbend), near Alashehr, Salyklœ, and Nymphi. A sulphur-mine exists two days' ride from Arta, and four from Butrinto, Albania, and there are other mines near the Dardanelles and at Alahtan, about six hours from Kassaba.

In the United States, sulphur is found native in Nevada, California, Utah, Virginia, Louisiana, and other States, and occurs in beds of considerable bulk in Uintah county, Wyoming, near Evanstown, where it is said to be quite pure ; also in some quantity in the Yellowstone Park, Montana, and in various localities in New Mexico. It is only worked to any extent in Nevada and California, and even there not on a large scale, the total production in 1880 being stated at under six hundred tons. Locally produced sulphur can not compete in price with imported Sicilian, on account of the cost of land transport ; it is, moreover, found to be often contaminated with arsenic, which greatly reduces its market value and limits its application. At the most important mine, called the Rabbit Hole, in Humboldt County, Nevada, the sulphur occurs as an impregnation in a white volcanic tuff or breccia, of Miocene age. The deposit is worked by regular mining, and the mineral, containing fifteen to forty per cent of sulphur, is dealt with by the steam process, the production being sometimes six tons a day. At the Pluton mines, California, the sulphur is found as a crystalline body scattered through a confused mass of decomposed rocks, and intimately associated with cinnabar, apparently occupying an ancient crater. The mineral is removed altogether, and the sulphur is either recovered by steam process, or, if both sulphur and cinnabar are in paying quantities, the mass is put into a mercury distilling furnace, and the sulphur is separated from the mercury by passing superheated steam into a chamber situated in front of the mercury-condensing chamber.

Sulphur is extracted from the earthy materials with which it is intimately associated in nature, by the following several means : 1. Dry heat (roasting the ore in mass) ; 2. Wet heat (melting out by the aid of aqueous solutions of salts, the salts being added to heighten the boiling-point) ; 3. Superheated steam ; 4. Chemical solvents. The great bulk of all the sulphur produced is extracted by apparatus belonging to the first class, and including the *calcarelle*, *calcarone*, and *doppione*.

Calcarelle.—The earliest system adopted in Sicily was the *calcarelle.* This consisted simply of a stack of ore six to fifteen feet square, built in a ditch three or four inches deep, and whose floor was beaten hard and sloped to a single point, permitting the molten sulphur to flow out by an opening termed the *morto.* In building the stack, care was taken to put the largest pieces of ore at the bottom, selecting lumps of gradually diminishing size as the top was approached. The mass was ignited at the summit. The construction of the stack usually occupied two days; on the third day the sulphur escaped by the *morto,* and on the fourth the *calcarelle* was pulled down. The air necessary for the combustion of a portion of the sulphur (to afford the heat required to smelt the remainder) was freely admitted at all sides; only the mineral in the center of the heap was heated without actual contact with the air, so that its sulphur was melted out instead of being burned (oxidized). Consequently about 6,700 pounds of sulphur mineral were needed to afford 385 pounds of sulphur, or a yield of 5·7 per cent; as the ore contained thirty-five per cent of sulphur, the consumption of sulphur as fuel was 1,960 pounds, in order to extract 385 pounds. In addition, the immense volumes of sulphurous acid emitted from the stack caused a terrible destruction of the agricultural crops in the neighborhood.

Calcarone.—Nearly all the sulphur prepared in Sicily is now extracted by the *calcarone* (or *calcherone,* as it may also be spelled). This, as is shown in Figs. 1 and 2, is formed by building a circular

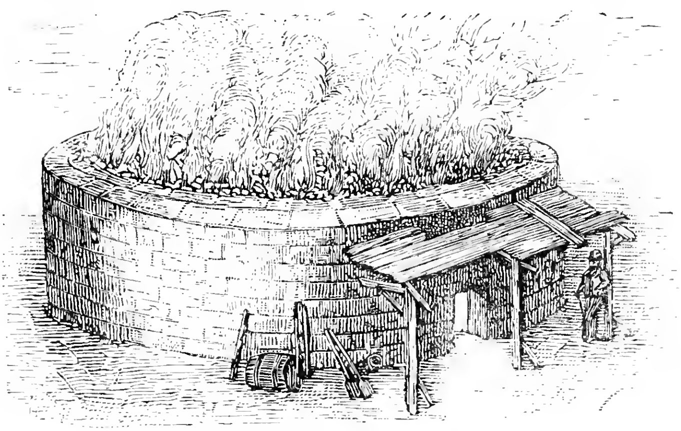


Fig. 1.

stone wall on an inclined sole. In front is the *morto* or outlet, having a height of four to six feet, and a width of two feet; over it is erected a wooden shelter for the workman in charge. *Calcaroni* may contain from two hundred to four hundred *casse* (each *casse* being equivalent to about six tons, and giving twelve to sixteen hundredweight of sulphur). The durability of the *calcarone* is governed by

the care exercised in its construction; ten years is not an unusual period. The charging of the *calcarone* is a matter of primary importance, as on it depends the yield of sulphur. The largest pieces of ore are selected for the first layer, leaving interstices between them; the size of the lumps gradually diminishes as the height increases, care being taken to form the walls of the *morto* with calcareous stones, so as to insure a passage being maintained for the escape of the liquefied sulphur. In adding the finest portions on the top, narrow channels, about two feet apart, are left for the draught to carry the heat down. The whole is covered with a layer of the refuse from previous operations. This layer is more or less thick, according to the state of the weather, because, the *calcarone* being built in the open air, variations of temperature and wind influence the progress of the operation; consequently means have to be adopted to prevent an undue access of air rendering the combustion too rapid. For instance, during a sirocco (local hot wind) there is danger of the sulphur contained in the ore lying at the side facing the wind being completely converted into sulphurous acid, and thus lost. The employment of a roofed shed would prevent much of the waste occasioned by climatic causes.

When the charging is completed, the *morto* is closed by a stone slab, and fire is communicated to the mass by means of little bunches of dried herbs, dipped in sulphur, which are thrust into the vertical channels before mentioned. Some six or eight days afterward, a hole is pierced in the top of the *morto*, by means of an iron rod; later, a

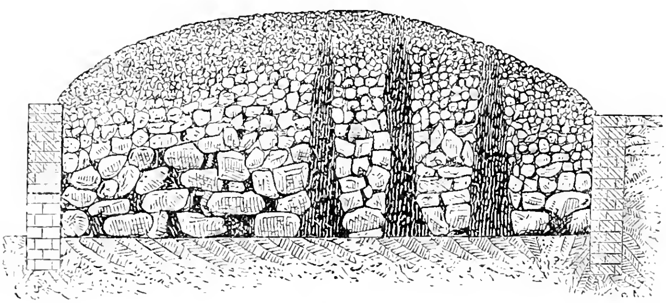


Fig. 2.

second hole is made near the floor. By these two openings the sulphur escapes, and is collected in wooden buckets (*gravite*), shaped like a truncated cone, and holding about one hundred-weight of sulphur. These buckets cost over two shillings, and serve only for three or four castings without wanting repairs. The outflow of sulphur lasts for a fortnight or a month. Commonly, the *calcarone* is left to itself when once the mass has been ignited, but then the loss of sulphur is much more serious. To insure good results, many precautions have to be observed, mainly connected with the nice adjustment of the draught, so

as to effect the maximum degree of fusion with a minimum of oxidation. When the operation is conducted during winter, the product is less abundant, and of inferior quality. After the charge is exhausted, a new one can not be introduced till the mass has cooled down, occupying a period of ten days to a month, according to the size of the *calcarone.* The discharging has to be done slowly and cautiously, on account of the sulphurous fumes liberated. The consumption of sulphur (as fuel) in the heating is about fifty per cent of the total amount contained in the ore. Thus, to obtain one ton of sulphur, there is consumed as fuel about another ton, worth say five pounds, and performing a duty which could be much more satisfactorily accomplished by two hundred-weight of coal, costing perhaps five shillings.

A great improvement in the Sicilian *calcarone* has been introduced by P. Le Neve Foster, and worked with good results, showing an increase of yield of thirty per cent above the ordinary plan. According to his description, the waste heat from an ordinary *calcarone,* after all the sulphur has been run off, is utilized to heat to the required temperature the charge of ore placed in his kiln, and, as soon as the moisture has been driven off and the heat is great enough, the charge is fired from the top. The combustion, fed with hot air containing some sulphurous-acid gas, is very slow, hence the loss of sulphur by burning is less than when, as in the ordinary *calcarone,* the ore has to be heated entirely by the combustion of the sulphur. The apparatus (shown in Fig. 3, prepared from a drawing kindly furnished me by the inventor) consists essentially of three parts: 1. The flue, or conductor of heat; 2. The kiln, in which the ore is treated; 3. The chamber for the condensation of the sulphur that is volatilized during the fusion, and in which it is collected.

The kiln may be of any suitable form to contain two charges of ore, but a rectangular chamber is found to be most convenient, with floor sloping toward the front. The chamber consists of four walls, preferably not covered with an arch, as affording greater facility for charging and discharging. The kiln communicates, by means of a flue, A, with the back of an ordinary *calcarone,* B, which furnishes the heat necessary for melting the sulphur from the one contained in the kiln, C. The upper portion of the *calcarone* should be covered with a layer of *genese* (spent ore), so as to prevent the dispersion of heat by any other channel than that offered by the flue, A, which is provided with a damper, D, so as to regulate the admission of heated air by openings, E, at the upper back part of the kiln. A rectangular opening, F, is left in the front wall of the kiln, from which the melted sulphur is run. This opening, if of sufficient size, may serve for discharging the spent ore at the termination of the fusion. From the upper part of the opening, and also in the front wall, slightly above the level of the floor, flues, G, communicate with a horizontal passage, H, which is made large enough to serve as a condensation chamber, on the walls of which

the sublimed sulphur collects. At one end of the chamber is a vertical chimney, I, provided with a damper, K.

The kiln is charged in the usual way by placing the large pieces of ore on the floor in such a manner as to leave passages for the flow of the liquid sulphur; the small pieces are next filled in, and the finer ore at the top. A few blocks of rough stone, or burned ore, are placed at the opening in front in such a way as to leave a vacant place for the melted sulphur to collect before being run off. When charged, the ore is covered with bricks laid flat, and on these is put a layer of *genese*, well rammed and wetted, so as to form a nearly impermeable

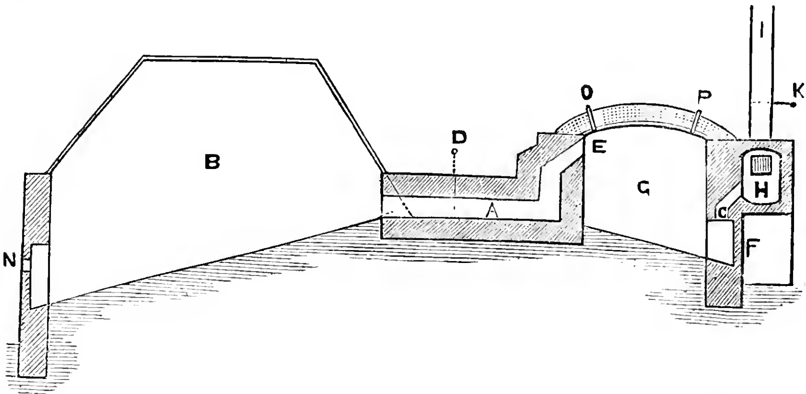


Fig. 3.

coating, with a slight slope toward the walls, in order that the rain-water may run off. The opening, F, in the front wall should be closed with a thin wall of plaster of Paris. The ore in the kiln, which is now ready for fusion, is put in communication with the spent *calcarone*, B, by opening the damper, D, and at the same time a small hole, N, is made in the wall that closes the opening in front, from which the melted sulphur has been run off from the *calcarone*, B. The current of air entering by the hole, N, and passing through the incandescent mass of ore, is thus heated, and enters the kiln by the flue, N, at a sufficient temperature. In this manner the heated mass of spent ore in the *calcarone* becomes a regenerator of heat, to be utilized in the kiln for the fusion of the sulphur that it contains. In the upper covering, two or more tubes, O P, are placed, and serve not only for observing the internal temperature by a thermometer, but also for firing the mass.

The combustion of the sulphur supplied with hot air, mixed with a considerable proportion of sulphurous-acid gas, proceeds slowly in the upper part of the kiln, and the liquid sulphur dropping to the floor, over the already heated ore, can not solidify and choke the passages, and so prevent the circulation of the heated air and products of combustion of the sulphur to the chimney; in this manner the operation proceeds with regularity. The success of the kiln is principally due to the

manner in which it is heated from the top and back toward the front and bottom, imitating, to a certain degree, the manner in which the heating of an ordinary *calcarone* proceeds, with this difference, that the heat is better utilized in the kiln, and therefore with less consumption of sulphur as fuel.

When the wall that closes the front opening, F, begins to heat, and the kiln is ready for running, a small hole is made with a pointed instrument, so as to allow the melted sulphur to flow off into wooden molds. The horizontal flue or condensing chamber, H, should have a sloping floor, and, when the temperature in it reaches the melting-point of sulphur, the flowers that have been deposited on the sides are liquefied, and run off. Toward the end of the operation it will be found prudent to close all the dampers as well as the hole, N, to prevent the overheating of the kiln, in which case the sulphur would become thick, and difficult to run off, and the yield would consequently be lessened.

The first cost of the structure is slight, as the materials necessary are usually at hand. The yield, too, is much increased; but, on the other hand, the extra cost in charging, discharging, and attendance, as compared with the ordinary *calcarone,* make a large hole in the increased returns.

It will require little reflection to see that only a small quantity of the finely pulverized mineral, necessarily produced in the operations of mining and breaking down the ore, could be dealt with in the *calcarone;* consequently, for a long time the bulk of this portion of the ore was simply thrown away, though it often assayed seventy per cent

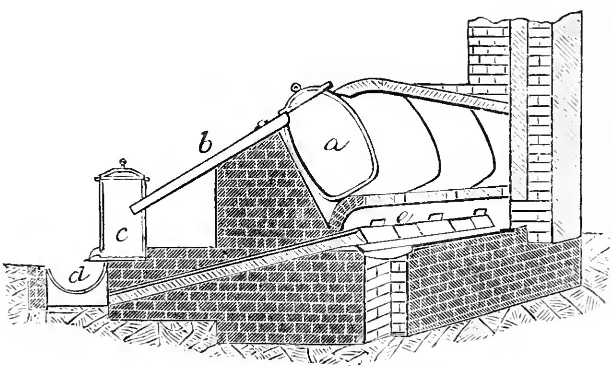


Fig. 4.

of sulphur. The *doppione* was one of the earliest successful structures designed to remedy this state of things. As shown in Fig. 4, it consists of a set (generally six) of cast-iron pots, holding about thirty to forty gallons each, arranged in a gallery furnace, *e,* so as to be completely enveloped by the heated vapors from a fire beneath. Each pot, *a,* communicates by a long arm, *b,* with a cooling condenser, *c,* for the

distilled sulphur, placed outside the furnace. The apparatus is generally employed on rich material, or on that obtained from the *calcaroni;* but it is also applicable to ores which are too poor to burn in the *calcaroni*, though the profit in that case must be small. The heat generated in the *doppione* is likely to encourage chemical action between the sulphur and any lime carbonate that may chance to be present in the mineral, creating a further loss of sulphur. The pots are charged and discharged by opening the lids, which are kept luted during the distillation. The volatilized sulphur is conducted by the cast-iron tub, *b*, into the receptacle, *c*, over which a small current of cold water constantly flows, reducing the sulphur to a fluid condition; it then escapes into the dish, *d*, beneath, whence it can be ladled into the molds. The pots last for about three hundred working-days, and the furnace serves about the same time with a couple of repairings. The workman is expected to turn out one hundred pounds of clean sulphur from every one hundred and nine pounds of *calcarone* sulphur.

The principle underlying the use of calcium chloride is that, while raising the boiling-point of water to about 239° Fahr. (115° C.), the melting-point of sulphur, it is cheap and inert in the presence of sulphur. The water to be used in the melting process is charged with sixty-six per cent of the calcium chloride, and heated to boiling, in which state it is run into the vessel containing the sulphur to be melted. No doubt the sulphur is efficiently melted, but the very slight difference in specific gravity between the sulphur and the associated impurities, from which it had been melted out, practically precludes any real separation taking place. Consequently, the process is virtually a failure, as I am assured by those who have worked it.

At the Rabbit Hole mines, Humboldt County, Nevada, advantage is taken of the liquidity of sulphur at 232° Fahr. (111° C.), to use steam at sixty to seventy pounds pressure for melting the sulphur out of the gangue. The apparatus employed consists of a cylindrical iron vessel, about ten and a half feet high, divided into an upper and a lower compartment, by means of a horizontal sheet-iron diaphragm perforated with one-fourth-inch holes. As soon as the upper compartment is charged with ore (about two tons), steam is introduced for about half an hour, and the sulphur, liquefied by the heat, flows down through the diaphragm into the lower compartment, kept at the proper heat by injection of steam, and escapes by an outlet, opened at intervals into a receptacle placed outside. When water commences to flow out with the sulphur, steam is injected at full pressure for a few minutes, to clear out as much as will come, and the solid residue is afterward removed through a door above the diaphragm. Each charge requires about three hours for its treatment. The process is adapted to ores which, for poverty and other reasons, can not be economically worked by *calcaroni*, or other recognized methods.

While hot water and steam have no solvent action upon sulphur,

but merely change it from a solid to a liquid state by the action of their heat, carbon bisulphide actually dissolves the sulphur and re-deposits it by evaporation. The plant necessary for carrying out this process is shown in Fig. 5. It is designed of dimensions suitable for dealing with twenty tons of raw sulphur mineral per diem, yielding fifty per cent of pure sulphur. The four extracting pans, *a*, *b*, *c*, *d*, have each a capacity of five tons, and are made of three-eighth inch

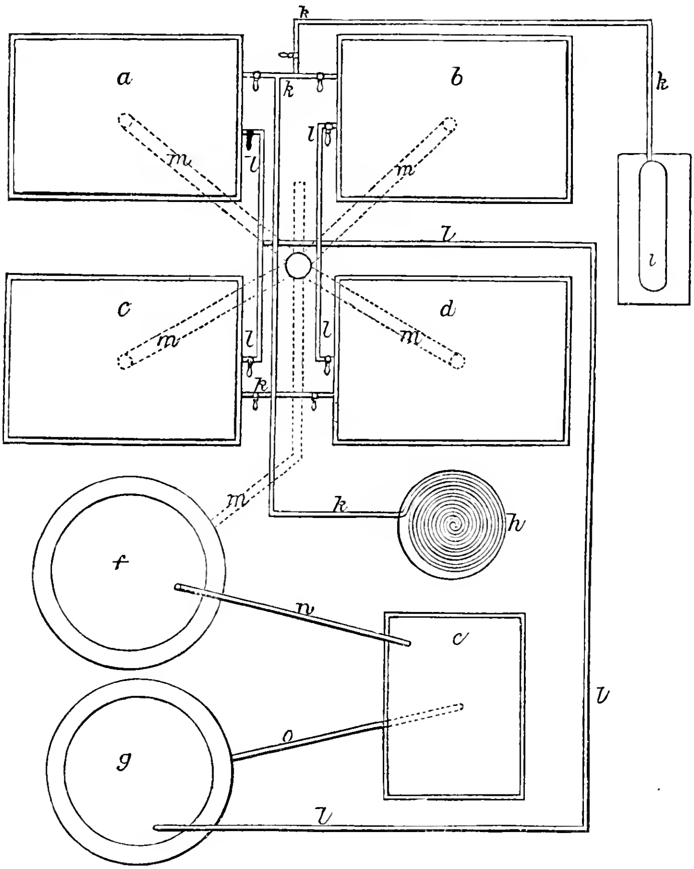


Fig. 5.

wrought-iron plate ; they measure six feet long, four feet wide, and four feet deep internally ; and are fitted with a perforated bottom diaphragm, with connecting pipes, *m*, leading to the underground solution-tank, *f*, with another set of pipes, *k*, for admitting steam from the boiler, *i*, and with a third set of pipes, *l*, communicating with the store-tank, *g*. The still, *e*, is a steam-jacketed " wrought-jacket " pan, six feet long, four feet wide, and four feet deep, with cast-iron ("loam casting") oval-shaped bottom and ends, one-half inch thick, and pro-

vided with a dome-shaped lid, having an inlet-pipe, *n*, and outlet-pipe, *o*; its capacity is three tons. The store-tank, *g*, measures ten feet in diameter, by seven feet deep, has a capacity of ten tons, and is constructed of half-inch wrought-iron plates. The worm, *h*, is a coil of two-inch pipe. The boiler, *i*, is of twenty horse-power nominal, and must be placed where it will be impossible for bisulphide vapors to find their way to the fire-hole. Force-pumps are required to pump the bisulphide from the store-tank, *g*, into the extracting-vats, *a*, *b*, *c*, *d*, previously charged with the sulphur mineral. When the sulphur has been completely dissolved, the solution is run into the tank, *f*, and thence pumped into the still, *e*, where, by the application of steam in the jacket, the bisulphide is evaporated, and passes into the store-tank, *g*, for future use, while the sulphur forms a deposit in the still, and is collected therefrom. When the extracting-pans have been emptied of solution, steam is let in so as to force any remaining bisulphide vapors into the worm for condensation and recovery, thus avoiding waste of bisulphide and consequent risk of fire and explosion by ignition of its dangerous vapors. The bisulphide is allowed to remain all night in contact with the charge. The diaphragm at the bottom of each extracting-vat may advantageously be covered with bagging-cloth to filter flocculent matters from the bisulphide.

For the preparation of "roll" and "flowers of" brimstone, the crude sulphur has to be again subjected to heat. The fusing apparatus (Fig. 6) generally consists of two cast-iron cylinders, *c*, measur-

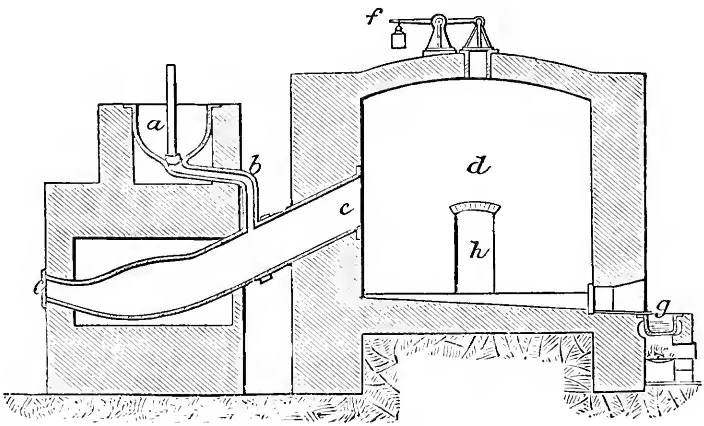


Fig. 6.

ing three feet long, by one foot in diameter, closed at one end by a door, *e*, and prolonged into a tube at the other, which leads into a brick-work condensing chamber, *d*. The retort, heated by a fire made immediately beneath, is completely surrounded by flues traversed by the heated vapors, which latter, before escaping to the chimney, heat a little pot, *a*, placed above the retort, and in direct communication

with it by means of the pipe, *b*. Into the pot, *a*, is introduced the sulphur intended for distillation. It is raised to a temperature of 257° to 302° Fahr. (125° to 150° C.), at which point the sulphur fuses, and flows, drop by drop, into the retort, *c*, where it is vaporized, and whence it passes into the chamber, *d*. The floor of this chamber is an inclined plane, converging to an aperture, *g*, by which the liquid sulphur flows out, while the "flowered" portion attaches itself to the walls of the chamber. These two forms (the liquid and the flowered) possess the same degree of purity, and their molecular difference depends only upon the varying grades of temperature under whose influence they are produced. An operation lasts about four hours. The door, *e*, facilitates the removal of spent refuse from the retort; the damper, *f*, regulates the draught and temperature in the chamber, *d*; and the door, *h*, gives access to the interior of the chamber, for the purpose of collecting the flowers of brimstone from the walls. The liquid sulphur, escaping at *g*, flows into a little pan, gently heated by a separate fire, and is thence ladled into wooden molds suspended in a bath of cold water to form the so-called "roll" or "stick" brimstone.—*Abridged from the Journal of the Society of Arts.*

PHYSICAL TRAINING OF GIRLS.

By LUCY M. HALL, M. D.

AN eminent French writer has said, "When you educate a boy, you *perhaps* educate a man; but, when you educate a girl, you are laying the foundation for the education of a family." He might have added that to this end the physical training was of equal importance with the mental.

In these days the subject of the physical training of young men is occupying much attention, and the discussions are broad and full of interest. The fault is, that the needs of both sexes in this respect are not equally considered.

An erect figure, an organism in which the processes of life may go on without the ceaseless discord of functions at war with each other because of abnormal relations—in short, the added advantages which a fine physical adjustment gives to its possessor—are as necessary to one sex as to the other, and for the same reasons.

If physical education and consequent improvement are things to be desired, it is not that a number of individuals as a result of this training shall be able to perform certain feats of strength or agility, but in its broadest sense it is for the improvement of the race, and the race can not materially advance physically, intellectually, or morally unless the two factors which constitute the race share equally in what-

ever tends to its greater perfection. Therefore, if in consequence of proper physical training men can do more work, live longer, and transmit to their offspring a share of this improved condition, women also should be so trained that they can do more work, live longer, and contribute to the higher possibilities of their offspring by supplementing instead of thwarting the promise which has been presupposed in the higher development of the male parent.

The question of the varieties and degree of exercise adapted to young women, and the many theories unsupported by observation which have been advanced, have done much to discourage the efforts and hinder the progress of those who have been honestly endeavoring to establish a reform from which definite results might be determined. The growing recognition of the necessity for thorough work in this direction is the lever which must in time remove all obstacles that have thus far stood in our way.

Professor D. A. Sargent, M. D., of Harvard College, a gentleman who has much practical experience in these matters, writes with regard to his observations in many of our female colleges and seminaries, "They all feel the demand for improvement in this direction, but for the most part their efforts are lame and impotent." He does not attribute this to lack of ability to come up to the required standards, but says that a need of encouragement and of suitable equipments exists.

Although I have been refused any statistical information, upon the plea that it was too early to make a summary of results, I know that in a few of the colleges for women the work of the drill-room is done with precision, and, what is better, enthusiasm. The late physician of one of these writes: "I am inclined to regard properly-conducted gymnastic exercises as decidedly beneficial to female students. There has been in some instances less headache, in others marked improvement where various disturbances to health had existed. I look for benefit to all students who practice regularly and faithfully. It strengthens more sets of muscles than walking or rowing; the latter takes them into the open air. They need both, in order to do the best work."

A lady, lately connected with a famous English college, writes that gymnastic exercises were employed, but were not so popular as walking, horseback-riding, and tennis. She adds, "Walks of fifteen or twenty miles were not so unusual as to excite remark," and mentions two friends who "did" thirty miles in a day without fatigue. "Indeed, one of them spent the entire evening afterward in dancing."

These facts certainly indicate that women are not by nature lacking in physical resources. The question, then, arises, What are the best methods of developing these resources?

It is a well-known fact that in women the vital grasp, tenacity of life, if we may so term it, is stronger than it is in man. This is perhaps a necessary provision, because of the added fact that through the

physiological processes of her being she is exposed to greater perils than are her stronger brothers. The existence of these conditions also renders her more liable to injury from any sudden and severe muscular strain, against which the system has not been fortified by previous training.

Some one has said that, in order to improve the health of the present generation, it would be necessary to correct the hygiene of our grandmothers! It is to be regretted that we can not begin thus early; but we can improve the grandmothers of the future by beginning with the young girls of to-day, and, through a sustained and systematic course of culture, help them to reach maturity with a physical endowment which will enable them more successfully to take their part in the battle of life. I would therefore say, begin the training early; where this is not possible, begin carefully.

Regulated gymnastic exercise is only one means of physical culture: modes of dress, out-of-door exercise, bathing, sleeping, the plays of young children, all are of equal importance.

If the little girl is to be reared with a view to perfect physical development, she should be dressed in as substantial clothing as her brother, and all trimmings and accessories necessitating extra care and stimulating a tendency to self-consciousness and the impression of sex should be avoided. If the boy is provided with a bicycle, the girl should be given a tricyle, and so with all the inducements by which he is stimulated to seek recreation in the open air. She should share them.

If, from the exuberance of health and vitality which this course engenders, the girl should chance to make as much noise as a boy, she should not be checked and repressed, while he is sent out-of-doors to have his frolic out. Above all, should the following of that routine custom in the education of girls, piano-practice, be avoided. The piano is the family vampire, which has sapped the vitality of thousands of young girls by keeping them from the healthful recreation and exercise which they so much need. It should be a rule of every educator that no girl should be allowed to take a course of music-lessons while she is pursuing the regular routine of her school-work.

As the girl approaches womanhood, let it be remembered that the need of healthful *mental* work is never greater than now. Muscle and nerve and intellect do not develop and grow strong upon sensational literature and fancy-work, and this is why girls at this age often grow morbid, sentimental, and self-conscious. Those instincts which should be kept in abeyance are stimulated into activity, and nervous, hysterical, or chlorotic conditions result.

Where the mind has been healthily directed, the system fortified by unstinted out-of-door recreation, and the muscles trained to endure prolonged effort without fatigue, the above conditions will be looked for in vain.

Walking, running, horseback-riding, tricycle-riding, lawn tennis,

swimming, rowing, skating, bowling, hand-ball, and general gymnastics, are the exercises best adapted to girls, and, for that matter, to any persons who wish a healthful and well-balanced rather than an abnormal physical development.

(The harmful and disfiguring accidents which often result from the rougher games practiced by young men, as well as the graver injuries which are the direct result of heavy lifting or a sudden severe strain upon certain sets of muscles, are matters to be deprecated, not emulated, and perfect physical training does not require such sacrifices.)

Where the girl has been allowed to grow to early womanhood neglectful of the requirements for proper physical culture, the question of what she may then undertake is a more serious one. If she be in college, the college physician should ascertain if there are any organic defects, and, if any exist, regulate her exercise in accordance with the requirements of the case. In nearly all cases, if the work is begun carefully, increased gradually, and sustained systematically, the best results will follow.

Let the girl be properly reared, and it will be found that Nature has imposed no obstacles against the attainment of the most healthful and highest physical standards which are commensurate with the normal development of the system.

FIELD EXPERIMENTS IN AGRICULTURE.

By H. P. ARMSBY,

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THE field experiment is both the oldest, the most common, and the most popular form of agricultural experiment. So soon as agriculture passed beyond the rudest and most primitive stages, the idea of testing the value of different manures, or of different modes of culture and treatment, or of divers kinds or varieties of plants by means of comparative trials on adjacent plots of ground, must have suggested itself, and so the agricultural field experiment was initiated. In its beginning it must have been of the rudest character, and yet the fundamental idea was essentially scientific, viz., to place the things to be compared under the same conditions, and let each bring forth its results; and while the details of such experiments have been gradually refined, and errors of method eliminated, they are still the same in purpose and essence.

Such experiments appeal powerfully to popular interest; and the reasons for this are not difficult to perceive. Field trials deal with subjects of constant and absorbing interest to the farmer in a way readily comprehended; they employ processes with which he is familiar through daily use of them; above all, they seem to promise results

directly applicable to practice. It is not to be wondered at, then, that in a time when agricultural experimentation is attracting attention as never before, field experiments should be multiplied on every hand, and that the public should regard the making of them as one of the chief ends, if not the chief end, of experiment stations and experimental farms. Both in Europe and America a vast deal of time and money has been devoted to their execution, and not only have organizations undertaken them, but private farmers have been urged to experiment on their own farms, both with a view to obtaining a better knowledge of the needs and capacities of their soils, and in the hope of advancing the science of agriculture.

The literature of the subject is voluminous, particularly in relation to the use of manures and fertilizers, and it might be expected that by this time our knowledge of these matters would be tolerably complete.

When, however, we come to look for the results of all this work, we find them surprisingly meager in comparison with the expenditure of time and labor which they have cost. That many valuable results have been reached goes without saying ; but relatively their number is small, while the number of uncertainties and contradictions is remarkably great. The weakest portion of agricultural chemistry is that relating to fertilizers and manures ; that is, precisely that part which we should expect to find well developed.

This state of affairs could not fail to impress thoughtful students of agricultural science, and cause them to seek out the reason why a method, which is apparently based upon a correct principle, and which has been executed with so much labor and care, has yielded, on the whole, such unsatisfactory returns.

Quite recently two German investigators, Professor Paul Wagner in Darmstadt, and Professor G. Drechsler in Göttingen, have given especial attention to this question, and have reached some interesting and important results, a brief account of which may not be uninstructive at a time when such general attention is being given to agricultural experimentation. These two experimenters have worked quite independently of each other, and their substantial agreement is strong evidence of the correctness of their conclusions.

We have said that the fundamental idea of the field experiment is essentially scientific ; but, while this is true, a more critical examination shows that the way in which this idea has been carried into execution has been far from scientific. The scientific method of experiment requires two things : 1. All the conditions of the experiment must be identical, with the exception of the one whose action is to be tested, and that must vary to a known extent. 2. The limits of error of the methods of weighing, measuring, etc., used, must be known, to the end that we may know whether any difference which may be observed is accidental or significant.

The field experiment, as commonly executed, has sinned against both these requirements, but particularly the first, in that it has *assumed* uniformity of conditions instead of *proving* it. One of the most important of these conditions is the soil. It has too frequently been assumed that simple inspection is sufficient to assure one of the uniformity of this factor, but this is far from being the case.

Uniformity of soil over any considerable area is by no means an easy thing to attain. In our Northern States, or in any drift-region, one has only to examine the sides of the nearest ditch in order to convince himself that the character of the soil varies from rod to rod, and almost from foot to foot, and to cause serious doubts as to the value of comparative field trials to arise in his mind. But even in localities where such striking variations do not occur, sufficient differences between adjacent plots are frequently found to invalidate the results of such trials. These are not only differences in the amount of available plant-food present; the physical properties of the soil play a prominent *rôle*. Even slight differences in the depth or texture of soil or subsoil, a greater or less proportion of organic matter, a difference in surface color, a variation in the moisture of the soil, may have a decided effect on the crop. Repeated trials have shown that it is practically impossible to prepare a series of plots whose natural crop-producing power shall be uniform.

Under these circumstances trustworthy results in field trials can be expected only if the amount of probable variation between different plots is known. A preliminary cropping without manure naturally suggests itself as adapted to furnish this information, and such preliminary trials are of great value. At the same time they are not of themselves sufficient. A different season may cause the relative yield of two plots to vary considerably in different years. Moreover, two plots might show the same yield when unmanured, and yet be differently affected by the same manuring. As a control on the natural variation of the soil, Drechsler depends chiefly upon duplication of manurings, the same treatment being applied to a number of plots scattered over the field. By this he aims to accomplish two things: 1. The average yield of these several plots is more likely to correspond to the response which the field as a whole would make to the same manuring than is the yield of any single plot. 2. The variations of the several plots from the average furnish a measure of the uniformity of the soil, and serve to show whether a given difference in the final results of two kinds of manuring is significant, or is simply accidental and less than the errors of experiment. This is not the place to enter into a description of all the precautions required in the conduct of such trials. Those interested can consult Drechsler's original papers. One point may be noted, however, viz., that differences in the season, whether wet or dry, e. g., may have a deciding influence on the action of manures, and that only continuing the experiments for a number of

years can eliminate this source of uncertainty in the interpretation of the results.

As regards the practicability of the method of exact field experiments as developed by Drechsler, it is worthy of remark that, while results which conform to its criteria are trustworthy, a considerable proportion of his own experiments have simply succeeded in demonstrating that the soil was too unequal to admit of successful field trials.

Wagner has attacked the problem in a different way His first attempt was to make field experiments upon very small plots, only two or three square metres in area, separated from each other by walls of masonry, and to compensate for the small size of the plots by the care with which they were treated. He also adopted the plan of repeating each manuring several times, as described above. The results were not satisfactory, however, owing largely to the unequal distribution of water among the plots, and after numerous experiments he has abandoned this method and adopted that of pot experiments. His pots are cylindrical zinc vessels, fifty centimetres (nineteen inches and a half) high and twenty-five centimetres (nine inches and three quarters) in diameter. These are uniformly filled with the carefully mixed soil, and are provided with an arrangement by which the water of the soil is automatically replaced as fast as it evaporates. The small size of the pots permits the use of pure materials as fertilizers, while for the same reason duplicate trials can easily be multiplied. The method in Wagner's hands has proved a practical one, and has already yielded some very interesting results.

It may seem that such a method as this is too far removed from the conditions of actual practice to afford results of any practical value. There is a degree of truth in this criticism. The conditions in such an experiment are different from those in the field. Wagner's method has one inestimable advantage, however, viz., that all the conditions of the experiment are under control. The importance of this is strikingly shown by considering the effects of a deficient supply of water, such as is liable to occur in any field experiment.

It is a well-known law of vegetable growth that that factor which is present in the least quantity in comparison to the amount needed—i. e., which is present in relatively the minimum quantity—is the one which chiefly regulates the amount of production. If, in a field trial, the supply of water holds this position, as it easily may, it and not the diverse manuring will determine the amount of crop. Moreover, as the plants grow larger and expose more leaf-surface, they exhale more water, and it might very well happen that a supply of water which was sufficient for a plot lightly manured might not be enough to supply the exhalation from the more luxuriant plants on a better-manured plot. The result would be, that the growth on the latter plot would be hindered, and the manure would not have a chance to show its full value. In pot experiments conducted according to Wagner's plan,

such a case could not arise, the water-supply being uniform and in excess of the needs of the plants. The same considerations apply to other conditions, of course, though less markedly than to the water-supply. In carefully conducted pot experiments it is possible to have practically all the conditions controllable, while duplicate trials will show the degree of accuracy obtained.

What, now, is the value of this method, as compared with properly conducted field experiments, in the study of agricultural questions? Can it replace them either partially or wholly? An intelligent reply to these questions must distinguish between the various kinds of problems which present themselves for solution.

In the first place, many purely scientific problems demand attention. These are of the first importance, for, until we can master them, all attempts to apply science to practice will have but partial and uncertain success. Such problems are, for example, the most suitable form in which certain fertilizing substances may be applied (sulphate or chloride of potassium, nitrates or ammonium salts, soluble or reverted phosphoric acid, etc.), the effect of differing degrees of fineness, or of a more or less uniform distribution at different depths in the soil, the effect of different manurings upon the chemical composition and feeding value of the plants produced, the specific needs of different plants as regards fertilizers, etc., etc.

Such problems as these can be solved only by scientific methods of experiment, in which all the conditions are under control. Just as the question, what substances are essential to plant-growth, was not solved by field experiments, but by the method of water-culture, in which no soil at all is used, so questions such as were just mentioned seem likely to reach their solution by a method almost equally removed from the conditions of practice. But while the method of pot experiments appears well adapted to resolve scientific questions, and while its results (if reached legitimately, and tested carefully) are true independently of any extraneous considerations, those results need to be tested under actual working conditions; not as to their truth—that is settled—but as to their applicability to practice. It is true, as a scientific fact, that certain varieties of feldspar contain several per cent of potash, and it is also true that potash is an indispensable element of plant-food; but he who should therefore try to supply potash to his crops by means of ground feldspar, would be likely to meet with very indifferent success. He would not thereby *disprove* the fact that feldspar contains potash, or that potash is indispensable to plants. He would simply show that to these two facts there must be added some information as to the availability of feldspathic potash as plant-food, and so his field experiment would be the starting-point of a new series of scientific investigations, which should show whether the first-named facts were capable of any useful application.

The method of exact field experiments, then, as developed by

Drechsler, has for its proper object the testing of facts obtained by pot experiments or by other scientific methods, as to their direct applicability to practice. It can never be a means of investigation itself, but it is indispensable to a proper utilization of the results of investigation, as well as in suggesting new directions for research. For these purposes it can not be too exact, and it would be well if those who are called to the conduct of such experiments would make themselves thoroughly acquainted with the difficulty of obtaining results which will endure careful criticism, and with the almost numberless precautions necessary thereto.

Other and ruder forms of the field experiment are omitted here. They are, or may be, of much practical value when carefully made and rightly interpreted, but their contributions to the *science* of agriculture are *nil.* The two methods whose general features have been described, however, are really means of scientific research. They are laborious because the subject is a difficult and complicated one, but by their conjoined aid we may hope to make sure if slow progress. The thing of prime importance is a clear recognition of the possibilities and of the limitations of each method.

CHOLERA.*

By Dr. MAX VON PETTENKOFER.

I. ITS HOME AND ITS TRAVELS.

CHOLERA is an infectious disease. By infectious diseases are meant those diseases which are caused by the reception from without of specific infective material into healthy bodies, which material acts like a poison. To the list of infectious disorders belong such different maladies as small-pox and intermittent fever. Infective material differs essentially from lifeless chemical poison in being composed of the smallest possible units of living matter which when taken into healthy bodies rapidly increase and multiply under certain conditions and by their life-growth disturb the health of the body. These germs of disease belong to the smallest units of life, to the schizomycetes, which lie on the border-land of the invisible, and which, according to their form, are known as cocci, bacteria, bacilli, vibriones and spirilla, and thirty millions of which, according to Naëgeli, hardly weigh one milligramme! Infective material is derived partly from sick individuals, in which case the disease is termed "contagious" and partly from locality (earth), in which it has developed, in which case the resulting disease is termed "miasmatic." It is obvious that when derived from both sources the resulting affection was, and even now is, designated "contagio-miasmatic." I am of the opinion that the

* Reprint of a special translation made for the London "Lancet."

"contagium" and the "miasm," which have given rise to much misunderstanding, would best be dispensed with altogether; and that the designation "infective material" (Infectionstoff), which is common to both contagium and miasm, should be divided into entogen and ectogen, according as the material is obtained from the sick body or the locality (soil). According to many, cholera would belong to the entogenous section, and according to others to the ectogenous division. The supporters of the first view might be termed "contagionists"; the supporters of the second "localists." As is always the case in medicine, the conflict of views is important, inasmuch as the measures to be adopted in the healing and prevention of a disease depend on the theoretical conception of it.

All readers know that cholera originated in the East Indies, and most individuals are also aware that the epidemic spread into Europe in the present century (1830). We shall first speak of its age in India, the home of cholera. There the disease appears to have existed at all times; not only at the time of the discovery of the sea-passage to India by the Portuguese, but long before, as the oldest Sanskrit writings show. Many hundreds of years before the birth of Christ the disease was accurately described and its epidemics spoken of as attended with *mahâ mârî* (*magna mors*, great death). In these writings the disease appears under widely different names, which are taken from the chief symptoms: 1. *Vishû dschikâ*, vomiting and sweating; 2. *Alasikâ*, cramps which bring on exhaustion and stiffness; 3. *Rilambikâ*, which is perhaps best translated by the term "collapse." Another word which is often used in India is taken from the Mahratta, *mordeshin* or *mordschi*, which has been translated into French as *mort de chien*, but which also means "collapse."

In the seventeenth and eighteenth centuries A. D. there are abundant proofs and descriptions of epidemics of this disease. The disease is best known in Europe under the names of cholera, cholera morbus, Asiatic cholera, since the epidemic of 1817 to 1819, in which the English army, under the command of the Marquis of Hastings during a war against the natives, was rendered unfit for fighting and almost annihilated. But cholera had never visited Europe till the present century, when in 1830 it appeared in Russia and spread to Poland, where war was prevailing. Since that time, sometimes at longer and sometimes at shorter intervals, cholera has appeared in Europe. The question why cholera remained a thousand years in India before it first began to migrate is one of great interest, but one which can not be satisfactorily answered. The principal consideration appears to me to be that the event happened at the time when intercommunication in all directions, both by water and land, had become more rapid. The first steamship appeared in the Indian waters at the beginning of the second decade of the present century. By land also intercourse was greatly accelerated. The Russians possibly

took cholera from India, Arabia, Afghanistan, or Persia, through couriers and stage-coaches. It soon became clear that cholera, the specific cholera-germ, was in some way or other propagated along the paths of human intercourse, and it also became evident that unless the germs found a suitable soil within a certain time they did not flourish. Observers soon discovered that cholera was more prone to appear in certain regions and to affect certain localities, while it shunned other districts ; and, again, that other regions were only visited at intervals of many years. It is also a fact that Asiatic cholera never yet appeared at a place which had not previously been in communication with a region where cholera prevailed ; and, further, that the disease from an infected locality never yet passed on to another place if the journey lasted a certain time without interruption. The large intercourse between India and Europe, more particularly England, by means of ships which sailed round the Cape of Good Hope, had never succeeded in carrying cholera from India to England ; it was only by the overland route that cholera reached England. Neither had the Cape or Australia ever been visited by cholera. It is possible that in the future the communication may be so much accelerated that cholera may get to these countries. In much the same way South America escaped during the epidemic (1830–1840) in Europe and North America. It was supposed that in South America yellow fever was enough to prevent cholera, or that this disease kept out cholera, until suddenly, in 1854, after a service of fast sailing-vessels between Philadelphia and Rio de Janeiro had been established, the chief town in the Brazils experienced a terrible epidemic of cholera. When cholera passes overland it dies out unless it finds a suitable soil within a certain time. Rainless deserts are unfavorable to cholera. Caravans which pass from infected localities through deserts have never spread the disease, provided the journey in the desert lasted at least twenty days.

Cholera always requires for its propagation favorable stations on land, and, as a rule, if the course of epidemics be traced, a gradual extension in successive years is found to take place in fixed directions. In the east and southeast of Russia, for example, cholera prevailed after it had raged in Persia in 1868 ; in 1869 eleven, and in 1870 thirty-seven provinces were affected, and among them five districts in Poland. In the year 1871 the epidemic spread into the west, east, and north of Russia, and succeeded in reaching East Prussia, when Königsburg was severely visited, so that from July 24th to November 8th, 2,012 individuals died there of cholera; while in Berlin only fifty-two and in Potsdam only seventy-one succumbed. In 1872 the epidemic reached Eastern Hungary, and in the following years reaped rich harvests in Germany. It has rightly been said, therefore, that cholera does not travel quicker than man. Nevertheless, the spring-like mode of progression of cholera is noteworthy : for example, it regularly jumps from Marseilles to Paris, or *vice versa*, passing over

Lyons, the second largest town of France. Or, watching the passage over smaller distances, in 1854 it went from Munich to Augsburg by railway, leaving intact the ten intermediate stations, although several patients alighted and some even died; and, notwithstanding that cholera raged at Augsburg and Lech, it never once sprang over the valley of Lech to the town of Friedberg, which is but a league distant. Or, to take a still narrower circle, cholera thrice (1836, 1854, and 1873) invaded Munich, and every time halted in those houses situated on the clay soil in the suburbs.

The capriciousness of cholera may be observed in its relations not only to space but also to time; at one time it infected Prussia and shunned Saxony, while at another it did exactly the reverse. In the year 1849 Berlin experienced its worst epidemic, an epidemic in which Saxony was but slightly affected (488 cases) and Bavaria not more so. In the year 1850, when the cholera in Berlin and its environs had almost subsided, the epidemic raged in Saxony until 1,551 deaths occurred, though Bavaria was not involved. In 1854 the matter was altogether different; then Munich and Bavaria had its worst epidemic, at which time the Industrial Exhibition was held at Munich, and the intercourse between Munich and Saxony and the whole of Germany was very active. The cholera did not, however, spread to Saxony. All the fatal cases of cholera in Saxony had taken the disease from Munich. The epidemic did not spread farther north; yet the inhabitants of Saxony and Prussia had sufficient susceptibility for the disease, as was proved when they went to Munich. It was in the year 1855 that a change occurred; then Bavaria was exempt, and the epidemic devastated Saxony and North Germany. What relation the extension from India by the agency of man may have to conditions of time and space, to local and periodical disposition, has yet to be worked out; but the fact of the existence of relations in time and space is as undeniable as that of cholera itself. The cholera-germ alone will not explain everything. We must now inquire into the differences between places which are and those which are not susceptible, and endeavor also to trace out the relations in time which obtain in susceptible places.

No doubt can be entertained that the configuration of the earth has a certain influence. Relatively low-lying sites are very favorable to cholera. Where the surface of the earth has an undulating outline, it will be found that districts and individual houses which are situated on the summit of the undulation very frequently have no, or only a very small, disposition to the development of an epidemic of cholera, while in the hollow of the undulation under like conditions the opposite holds good. The truth of this statement is seen in single districts where parts or single houses exist on the summit and others lie low.

Another feature which is found in every epidemic is the falling off of the disease in the neighborhood of and on mountain-ranges. The Himalayan Mountains, those of Lebanon and the Alps, have always

formed the places of refuge for fugitives from cholera. Now and then an epidemic occurs in the mountains ; these exceptions will be dealt with later. The immunity, or the slight susceptibility, of mountain-ranges for cholera is witnessed in India as plainly as it is in Europe. A familiar example is the complete freedom from cholera of the hill-stations along the Himalayas, in which, through frequent changes of troops, the cholera has every chance of being taken up from the plains. In the severe epidemic of 1869 there were only two cases of cholera in nineteen hill-stations. A similar experience is met with in narrower areas. For instance, in Munich, 1873–'74, the frequency of cholera was widely different in the seven barracks of the garrison. In the low-lying Isar Kaserne (occupied by cuirassiers, heavy cavalry regiment), out of one thousand men there were forty cases of cholera ; in the high-lying Max II Kaserne (with two field-artillery regiments) only three cases, and this without there being any difference in the construction of the caserns, the occupation or the diet of the men, or the drinking-water. Another local factor, which is also very evident, is the nature of the soil. Where the soil is compact, and not, or very slightly, permeable for water and air, the development of cholera is much hindered. Some time ago Jameson, in his description of the epidemics of 1817 and 1819 in India, said, "Cholera does not appear to like a rocky soil." French epidemiologists (Boubée and others) have said the same thing. I studied this point in Bavaria in 1854, and then collected so many facts that I came to the conclusion that cholera requires for its epidemic development a porous soil through which air and water easily percolate, and that a compact soil was decidedly inimical. It will be sufficient to give a couple of illustrations. When the cholera broke out in Munich the inhabitants scattered themselves on the mountains. Many settled in the valleys, where several fell ill and died. The greater part of the town in which the better hotels were situated lies upon compact chalky soil, and the smaller part was built upon alluvial soil. In this part the cholera assumed an epidemic character. In the higher-lying districts (Schrödelgasse) the epidemic began in the beginning of August, and in the lower lying areas toward the end of September, while the greater part situated on chalk was not affected. Among the Jura Mountains to the left of the Donau lies a village called Kienberg, which is built on rock. In this village the cholera broke out so fiercely that within a month thirty per cent of the inhabitants died. When I went there I found many houses emptied, while other houses had not had a single case of illness. I then thought that the drinking-water was at fault. But the whole village drew water from a single spring at the foot of the slope on which the village was situated. From a study of the soil I found that all the houses built upon porous and rather loamy sand had been attacked, while those which lay upon the compact soil of the Jura rocks had escaped. The greater part of Kienberg stands upon a cleft of the

mountain which had been filled up by fine soil which had resulted from the wearing down of the higher parts of the mountain (alluvial soil). That some doubt should be thrown on the decision of the commission which had adopted my views on the influence of the natural state of the soil on cholera was not to be wondered at. I spared no pains, however, in going to the Krain and Karst Mountains, where cholera apparently was raging on a bare, rocky soil, and instead of contradiction I found a further corroboration of my views. The towns lying among these mountains were found to suffer from an affection which unquestionably proceeds from the soil—namely, ague. The mountains are freely cleft, and the clefts are filled with porous soil, allowing of the free percolation of water and air, so as to be nothing more than an alluvial soil. Here streams rush down the mountain-side, turn off at its base, and run on richer still in water. You may often find there a cleft having the shape of a funnel, filled with porous earth ; the nature of the cleft and its contained earth may be determined by sinking a so-called Dolione, when the bottom will be found to be solid stone. Through the Adelsberger growth the rapid Poik flows ; and on the other side of the mountain in which the grotto is situated the waters of the Poik roll off under the name of the Unze ; the Unze again flows off at the base of a mountain, as a navigable river, on the other side of Laybach. As I proceeded from Laybach to Novomsto (Neustadtl), I saw shining in the distance before me and far below the mountain a village, which turned out to be Rasderto, where I learned from my companion, a schoolmaster, that ague prevailed, and, indeed, I found many sufferers confined to bed from this complaint. Rasderto lies below the sites which the cholera infested. At the base of the rocky hills on which Rasderto is situated, there flows a stream which is so powerful that it turns a mill.

In order to study the cholera at Malta I proceeded thither in 1868 at my own expense. Mr. John Simon procured me the necessary introductions. On arriving in the harbor of Valetta I was forcibly struck with the rocky nature of the soil. The rocky hills rose high above the water, and on alighting on shore my feet encountered the resistance of bare rock. I ascended the steps hewed out of the solid rock, by which means I reached the plateau, on which the greater part of the town is built. A promenade, which was also shaped out of the natural rock, led me to my hotel. I now became very desirous for a further study of the place. Mr. Inglott, at that time the chief medical officer of the hospitals in Malta, and Dr. Pisani, a distinguished Maltese physician, rendered me very efficient aid in my researches. They often wondered why I had determined to visit Malta. How often did they say to me, when I questioned them on the nature of the soil of this rocky island, "Our rock is not rock in your sense of the term, but it is a sponge which sucks up everything which falls upon it"! Investigation proved that the Maltese rock was as porous

as Berlin gravel, and that more than a third of its volume consisted of air-containing pores. It is so soft that it can be cut and sawed like wood. As visitors may purchase wood-carvings from Oberammergau and Berchtesgaden, so one can obtain carved-work of Maltese stone. Tiles cut from Maltese stone find a ready sale in Italy, where they serve to decorate the floors of rooms, where, owing to their porous nature, they are not so cold to the feet as stone tiles. Maltese tiles are as good as wood without being so inflammable. Moreover, of the same stone vessels are made which English sailors use to filter their drinking-water. Turbid water when poured into such vessels filters off as a transparent fluid. It will be readily understood that I now no longer concerned myself as to an explanation when I heard that an epidemic of cholera had broken out at a place which apparently had a compact soil.

Not only does the physical nature, but also the chemical constitution, of the soil have an influence on the occurrence of cholera—to wit, the presence of organic matter and water. The influence of the soil on the development of infectious diseases can only be understood by a study of the organic processes which take place in it. The processes are eventually dependent on the action of the lowest organisms, which require for their growth a certain temperature, so much water, air, and food-stuffs. In order to explain the occurrence of cholera on such varied soils as those composed of granite, sand-chalk, and shell-chalk, we must suppose that the soil contains in its interstices much organic matter and water. Farmers know how useless pure soil is, whereas the luxuriant growth of plants when the ground is manured is well known to all. These observations are applicable to the lowest plants, the bacteria, no less than to grain and vegetables. The germs of putrefaction and fermentation abound in the free atmosphere, but they only grow and multiply where they find suitable food. The hygienic uses of cleanliness here find their explanation and scientific foundation. The refuse from houses, dissolved or suspended in water, forms an excellent nutritive material for the lowest organisms which are so harmful to us. Emmerich has shown that the purest water after being used to clean the floor of a room contains in a very short space of time abundant germs of disease, so much so that a drop of it injected under the skin of a rabbit or Guinea-pig is followed by a fatal result. With this dangerous slop-water it is the custom to charge the earth in and about our dwellings. Since man began to live in towns where drainage was in vogue, diseases dependent on conditions of soil (cholera and typhoid fever) have undergone a striking decrease. Just as a field, when excessively manured, does not always remain good for vegetation unless remanured, so is it also with the uncleanliness of the soil in the neighborhood of our houses. As soon as we cease to make unclean—to manure—so soon do our towns begin to purify themselves, just as a churchyard after a time becomes purified. In a simi-

lar fashion does good drainage act in cleansing our towns, and the necessity of a pure water-supply is thus vindicated. It is in this way that, according to my view, cleanliness acts as a deterrent to cholera. Cholera-germs may come, but they can not fructify under such circumstances. That sites naturally exist which, without human interference, are unfavorable to cholera, has already been shown.

Where water entirely fails the organic processes soon come to an end; this is true of the soil of the earth. In rainless deserts the soil is dry except the most superficial layer during the night. In such desert places no organic processes can go on; this is shown not only in the absence of vegetation, but may be proved by an investigation of the nature of the air of the soil ("Grundlutt"); this air under ordinary circumstances contains much carbonic acid, which proceeds from the processes of organic life; but where the soil is free from water the air of the soil much more closely resembles that of the atmosphere above it. This fact has been experimentally proved by Professor von Zittel by a comparison of the free atmosphere with the air of the soil of the Libyan Desert. These observations are believed to explain how it is that cholera does not appear on a very dry soil. Just as too much water is bad for certain plants, so is it also for some members of the lowest class of the vegetable kingdom. It is likewise conceivable that the organic processes in the soil on which epidemics of cholera depend may be effectually checked by an excess of subsoil-water or by a want of material. Micro-organisms have been divided into two classes: anaerobe and aerobe. If now we have to deal with an organism which requires oxygen for its existence (aerobe), it is not difficult to understand how the excess of water might deprive the soil of the necessary proportion of air. The more the pores were filled with water the less air would be contained in the soil. In heavy clay soils the water drives the air completely out, and thorough desiccation would be required to replace all the air. Klebs and Tommasi-Crudeli have already discovered a micro-organism which flourishes only in a moist soil containing air—the bacillus malariæ.

We shall now inquire into the time relations of cholera at its permanent home in Lower Bengal. Dr. John Macpherson has, in his work on "Cholera in its Home," tabulated the number of cases of death from cholera in Calcutta for each month of the year for a period of twenty-six years. I have calculated and arranged in a tabular form from these statistics the average number of deaths in each month, and contrasted each month with the average rainfall at Calcutta. (See Table I.) It will be seen how unequally distributed is the great fall of rain, which is two or three times greater than in many districts of Germany. Calcutta has a rainy season, which begins at the end of May and ends at the beginning of October. The cholera decreases from the beginning and increases again toward the end of the rainy season. It reaches its maximum during the driest and hot months

TABLE I.

Average Frequency of Cholera, and Average Rainfall (in Inches) in Calcutta.

—	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Cholera	275	359	566	745	513	243	153	132	151	239	320	317	4013
Rain	0·21	0·42	1·13	2·40	4·29	10·1	13·9	14·4	10·4	4·2	0·9	0·13	62·58

(March and April), and its minimum is attained during the wettest and hot month of August, so that the curve of cholera falls while that of rain rises. The rise and fall of endemic cholera is constant, while the prevalence of cholera in its epidemic form is very variable. In the Punjaub the rain-winds (monsoons) bring with them the cholera. This apparent contradiction of the experience above mentioned may be explained by considering that the monsoons bring to the Punjaub the necessary moisture which is believed to be requisite for the development of an epidemic of cholera. Rain falls in the Punjaub at the same time as in Lower Bengal, but in smaller quantity. The average rainfall at Lahore is twenty-two inches, as compared with sixty-two inches at Calcutta ; so that in Lahore for the greatest part of the year the soil is too dry for cholera. That these claims are substantial will be granted by a study of the rainfall and related circumstances in other parts of India. This is well seen at Madras, as indicated by Table II. At Madras the average rainfall is about forty-eight inches,

TABLE II.

Average Frequency of Cholera, and Average Rainfall (in Inches) in Madras.

—	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Cholera	194	191	123	64	65	59	164	191	186	143	93	104	1577
Rain	0·89	0·22	0·48	0·68	2·26	1·65	3·46	4·38	4·58	10·9	12·90	5·42	47·82

and is therefore midway between those of Lahore (twenty-two inches) and Calcutta (sixty-two inches), but the quantity of rain in the several months is different. The greatest quantity of rain falls in November, and Madras is not under the influence of the southwest, but of the northeast monsoon, and the rainy season extends from July to December. As Madras lies farther south than Calcutta, and the quantity of rain is twenty-five per cent less, it is plain that the desiccation during the dry and hot season would be much greater there than in Calcutta. And this state of affairs is reflected in the vegetation. April, May, and June are like winter months ; the leaves begin to fall ; the verdure fades away, and the sap descends to the roots of the trees, not because of the cold, but on account of the excessive dryness. It is at this period that cholera is at its minimum. In July, when the rain begins to fall, cholera increases, and reaches it maximum in August. The rain continues, but the cholera decreases, owing to the excessive dampness of the soil ; so that in November a second minimum in the number of cases of cholera is met with.

In order to inquire into the accuracy of these views, another observation, taken from India, may be cited. Places which are outside the region of endemic cholera, and which have a rainy season at the same time and of about the same amount as Calcutta, have the same amount and periodicity of cholera. Such an instance is afforded in Bombay, which is a city as large as Calcutta, and the rainy season of which depends on the southwest monsoons. In a table which shows the frequency of cholera, the rainfall, and the temperature on the average for a period of fifteen years, it is evident that in all three particulars there is a remarkable correspondence between Calcutta and Bombay. (See Table III.)

TABLE III.

Average Frequency of Cholera, Average Rainfall, and Average Temperature (in Degrees Centigrade), at Bombay.

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Cholera	235	213	263	295	294	278	162	93	60	76	95	163	2217
Rain	0·03	0·01	0·01	0·02	0·41	20·02	22·69	13·10	9·47	2·01	0·27	0·09	68·12
Temperature.	24·1°	24·7°	26·2°	29·1°	30·4°	29·1°	25·2°	25·2°	27·1°	27·2°	26·2°	24·7°	....

The temperature has been given for the reason that it brings out the fact that temperature has not much influence on the progress of cholera. That Bombay is not within the endemic area of cholera is sufficiently testified by the results of the statistics for fifteen years. During this period there were three years in which no epidemic occurred. That a whole year should pass without the occurrence of a single case of cholera in Bombay is not to be expected, when the active intercourse between it and the endemic areas is borne in mind. If the table of averages relating to Bombay be compared with that of Calcutta, the resemblance is seen to be striking. The maximum incidence of cholera is seen to occur in both in April, and the minimum is found in Calcutta in August and in Bombay in September. After this minimum the increase takes place equally in both cities. The years during which no epidemic occurred in Bombay were characterized either by too much wet or too great dryness. Thus, in the years 1852–'53, the diminished frequency of cholera followed on a period of great wetness, and that of 1860–'61 came on after a very dry season. That this dependence on the weather is really sound is shown by a study of the years immediately following the lessened intensity of cholera. The years 1853–'54 and 1861–'62 in Bombay showed the same rhythm for cholera as Calcutta; whereas, on the contrary, the year 1858–'59 in Bombay had the same abnormal rhythm as Lahore. The average number of deaths from cholera in Bombay in March was 253, in April 295, and in May 294. In June, when the monsoons begin, the number further diminishes. The number of deaths in March, 1859, was 9, in April 7, in May 69, and, when in June the monsoons set in and 26·8 inches of rain fell, the number rose to 843, while the mean for June

was only 278. After dry weather Bombay also shows, like Lahore, "monsoon cholera."

Cholera in India, as is well known, has likewise a remarkable relation in time to the years of drought in India. If rain once fail, or be very small in amount, a famine necessarily follows. Distress is then felt both in Lower Bengal and in the Punjaub, but the cholera only appears more severely in Lower Bengal and avoids altogether the Punjaub. The dependence of epidemics of cholera on the time of the year (i. e., on the moisture of the soil) comes out well in countries outside India, as, for example, in Germany. In the kingdom of Prussia from 1848 to 1860 cholera was prevalent every year, though its incidence varied in intensity and in different provinces. During this period cholera was as much at home in Prussia as in India. Brauser has collated the cases of death from cholera week by week for the thirteen years, 1848 to 1860. The numbers for the different months are as follows: April, 112; May, 446; June, 4,392; July, 8,480; August, 33,640; September, 56,561; October, 35,271; November, 17,530; December, 7,254; January, 2,317; February, 842; March, 214. The numbers are founded on statistics, and it is proper to investigate the possibility of errors therein. No objection can be made to the Prussian statistics, for the numbers are too great to be vitiated by casual error. In India the statistics may not be so trustworthy, because registration is sometimes defective. Some cases of death from cholera may not appear as such, and perhaps some deaths may be falsely registered as due to cholera. The Indian statistics have, therefore, only been given for large cities, where more attention is paid to correct registration. The errors which may occur extend over all the months of the year, and are scattered, so there is less liability to perversion of the truth. And there is no need to prove absolute numbers, for relative statistics are sufficient. Further, in the garrisons and prisons of India, where physicians abound, the statistics are nearly as good as in Germany, since cholera is a disease so easily recognized. That a large series of numbers is able to eliminate to the vanishing-point the unavoidable errors of statistics is shown by an instructive example of the statistics of typhoid fever in Munich. Buhl, in studying the relations between the occurrence of typhoid fever and the state of the subsoil-water, made use only of figures obtained from the general hospital during the years 1856 to 1864, where every diagnosis was confirmed or overthrown by *post-mortem* examination. [Pettenkofer here devotes considerable space to the discussion of the question, dealing chiefly with the possible inconsistencies in the certificated causes of death. He seems to prove that the difference between the numbers gained by actual observation and those obtained by calculation is so small that it may be disregarded.] It is considered that since the rate of death from typhoid fever in the general hospital is on the above showing a fair representative of the death-rate in the

town of Munich, so the numbers concerning cholera obtained from the barracks and prisons of India may be taken as a good sample of the rate of mortality from cholera in the cities themselves. Bryden has given support, in his work on the time and space distribution of cholera in India, to the reports of barracks and prisons. That cholera should attain its greatest frequency in North Germany during the months of August, September, and October, and that winter should seldom see an epidemic, may be explained by the temperature which prevails in the air and earth. In the class of ectogenous infectious diseases, to which cholera belongs, the temperature, as in all organic processes, has a decided, though it can not be the chief, influence. That cholera is not very dependent on temperature is evidenced by the possibility of the occurrence of an epidemic of cholera during the winter. Why cholera spreads more during the summer and early autumn, as compared with winter and spring, must depend on other causes than temperature.

It is clear, in my opinion, that the soil and the moisture of the soil play a principal part. The dampness of the soil is, under certain conditions, clearly related to the subsoil-water, "Grundwasser." Epidemics of cholera abound during the time that the "Grundwasser" is falling, when the earth is comparatively dry. By "Grundwasser" is to be understood that condition of dampness of a porous soil when all the pores are filled with water. If water and air together fill up the interstices, then the soil is called simply damp. I have so long and so often spoken on the influence of the rise and fall of the ground-water on the frequency of typhoid fever and cholera, that I imagine a great many scientists credit me with the view that subsoil-water is highly harmful. But such is not the case. The subsoil-water is merely an indication of what is going on, and has no more to do with the actual processes than a dial and the hands have in the going of a clock. The fall of the ground-water by pumping away, or the rise of ground-water by the damming of a stream, has not the least effect on typhoid fever or cholera in the neighborhood. The observation of the level of the surface of the water in springs as an indication of the state of the subsoil-water is of no value from an etiological point of view, unless the spring be independent of the nearest water-course, and unless at the time of the observation the real state of the spring is a true reflex of the condition of the subsoil-water in its neighborhood. When the information, however, is obtained properly from springs free from objection, then the condition of the ground-water gives the state of moisture and of exchange in the overlying layers much more accurately than an observation made on the atmospheric downfall (rain and dew). Rain may fall for a week without causing any rise in the subsoil-water, and again a rise may occur when there has been no fall of rain for some time. The perusal of Professor Franz Hofmann's work, published in the "Archives of Hygiene," on the movement of subsoil-water.

may be safely recommended. When an epidemic of cholera occurs in winter, then a relatively low state of the ground-water is found to prevail. In Munich three epidemics prevailed during the cold months: the first occurred between October and March, 1836–'37; the second from July to November, 1853–'54; and the third from July till April, 1873–'74. All three epidemics were associated with a relatively dry state of the earth, as was proved also by meteorological data concerning the rainfall. No investigation has been made as to the state of the ground-water during the period 1836 to 1854, but this investigation was first begun in 1856, so that for 1873 and 1874 the data were available; and it is only on the assumption that the condition of the soil as regards moisture was abnormal for the time of year that the long duration and strange division of the last epidemic could be accounted for. The subsoil-water sank from the end of June, 1873, till the beginning of August. On that occasion the germs of cholera probably came from Vienna, where the epidemic had prevailed since April. Two cases coming from Vienna, one in June, the other in July, could be vouched for. At the end of July the first illness from cholera occurred in Munich, but in individuals who had never come in direct contact with the infective cases. In every fresh outbreak, in 1836, in 1854, and in 1873, the same part (the northeast) of the town was the first to suffer. As the epidemics of 1854 and of 1873 developed at the same time of the year (the end of July), so by the middle of August the height of the epidemic was reached; it then fell off rapidly during September; during the whole of October only isolated cases occurred; and by the middle of November the epidemic had ceased in the higher lying parts of the town. It was thought that the disease had become extinct, and notwithstanding that it was considered strange that the summer epidemic had chiefly fallen upon the higher lying parts of the town, while the lower lying districts on this occasion had been altogether spared. In the middle of November, when the weather became colder, the epidemic reappeared, and attacked chiefly those lower lying districts which had escaped in the summer. It is impossible to trace the progress of contagion in time and space from one individual to another. The contagionists can not maintain that the unexpected falling off of cholera was due to the protection afforded by the previous prevalence of the disease, seeing that the lower lying districts had escaped the epidemic, and that the other inhabitants two months later suddenly lost their protection. Any one who studies the movements of the ground-water in Munich for the year in question will find that in the first half of August an event occurred which in suddenness and unexpectedness rivaled the retrogression of the epidemic in the second half of August. In the first half of this month there fell an abnormally large quantity of rain (one hundred and seventy-one millimetres), which excessive rainfall was the largest amount ever registered since the observations had been begun. The consequent wetness

of the soil was reflected in a great abnormal rise in the ground-water. But from August onward through the winter, and till the beginning of the year, the amount of rain and dew which fell was again far below the average, and the ground-water steadily decreased. In the middle of April, 1874, it again began to rise, and then the epidemic of cholera ceased. The abnormal fall of rain in August, 1873, in Munich had the same effect on the cholera there as the southwest monsoons regularly have on the disease in Calcutta. In the relative dryness which follows this excessive wetness the epidemic process is continued as a winter invasion.

Munich and Augsburg are very much alike in situation and in meteorological factors. Both places lie in a direct line not sixty kilometres apart. But that differences in the amount of rainfall may occur is proved by the year of cholera 1873. In Munich, in spite of the excessive fall, the amount for the whole year was hardly up to the average; in Augsburg the excess above the average was thirty per cent. In 1873 the rainfall at Augsburg approached to that of the average at Salzburg. The distribution of the rainfall was different in Augsburg as contrasted with Munich, and the same difference in the history of the cholera holds good of the two towns. Augsburg had an epidemic of cholera in 1854, but none in 1836 or 1873, when only a few isolated cases occurred. That Augsburg in place and time and in individual disposition is susceptible of an epidemic of cholera was seen in the year 1854, when about three per cent of the whole population was destroyed by the malady, while Munich lost that year but two and a half per cent. If the appearance of cholera in the two places mentioned differed only in the time required for the transit from one city to another, then the germs of cholera must pass either from Munich to Augsburg or *vice versa*. In the year 1836 Augsburg remained free from cholera, which infested Munich for six months. At that period no observations on the rainfall were made, but no doubt exists that cases of cholera passed, without isolation or disinfection, from Munich to Augsburg. These facts prove that cholera is a miasmatic disease, and may be wholly independent of human intercourse. For the year 1854 meteorological data are obtainable, and this year had as dry a season in Augsburg as in Munich, while at both places cholera prevailed. In the year 1873 the case was different. Then there were in Augsburg regulations for the prevention of the spread of cholera, without which precautions, be it noted, in 1836, Augsburg remained free from the disease. Nevertheless, cholera did not visit Augsburg in 1873, during which period stringent measures of prevention were also in full force at Munich. Such considerations lead to the logical conclusion that what saved Augsburg did not relieve Munich. Further, Munich remained free from visitation in the humid summer of 1866, when cholera prevailed in North Germany; so that no importation of cholera to Munich took place from the seat of war.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XLIV.—THE COOKERY OF WINE (*continued*).

THE paternal tenderness with which wine is regarded, both by its producers and consumers, is amusing. They speak of it as being "sick," describe its "diseases" and their remedies as though it were a sentient being; and its diseases, like our own, are now attributed to bacilli, bacteria, or other microbia.

Pasteur, who has worked out this question of the origin of diseases in wine as he is so well known to have done in animals, recommends (in papers read before the French Academy in May and August, 1865) that these microbia be "killed" by filling the bottles close up to the cork, which is thrust in just with sufficient firmness to allow the wine on expanding to force it out a little, but not entirely, thus preventing any air from entering the bottle. The bottles are then placed in a chamber heated to temperatures ranging from 45° to 100° C. (113° to 212° Fahr.), where they remain for an hour or two. They are then set aside, allowed to cool, and the cork driven in. It is said that this treatment kills the microbia, gives to the wine an increased bouquet and improved color—in fact, ages it considerably. Both old and new wines may be thus treated.

I simply state this on the authority of Pasteur, having made no direct experiments or observations on these diseases, which he describes as resulting in acetification, ropiness, bitterness, and decay or decomposition.

There is, however, another kind of sickness which I have studied, both experimentally and theoretically. I refer to the temporary sickness which sometimes occurs to rich wines when they are moved from one cellar to another, and to wines when newly exported from their native climate to our own. The wines that are the most subject to such sickness are those that are the most genuine—the natural, unsophisticated wines, those that have not been subjected to "fortification," to "vinage," to "plastering," "sulphuring," etc.—processes of cookery to be presently described.

This sickness shows itself by the wine becoming turbid, or opalescent, then throwing down either a crust or a loose, troublesome sediment.

Those of my readers who are sufficiently interested in this subject to care to study it practically should make the following experiment:

Dissolve in distilled water, or, better, in water slightly acidulated with hydrochloric acid, as much cream of tartar as will saturate it. This is best done by heating the water, agitating an excess of cream of tartar in it, then allowing the water to cool, the excess of salt to

subside, and pouring off the clear solution. Now add to this solution, while quite clear and bright, a little clear brandy, whisky, or other spirit, and mix them by shaking. The solution will become "sick," like the wine. Why is this?

It depends upon the fact that the bitartrate of potash, or cream of tartar, is soluble to some extent in water, but almost insoluble in alcohol. In a mixture of alcohol-and-water its solubility is intermediate —the more alcohol the smaller the quantity that can be held in solution (hydrochloric and most other acids, excepting tartaric, increase its solubility in water). Thus, if we have a saturated solution of this salt either in pure water or acidulated water or wine, the addition of alcohol throws some of it down in solid form, and this makes the solution sick, or turbid. When pure water or acidulated water is used, as in the above-described experiment, crystals of the salt are freely formed, and fall down readily; but with a complex liquid like wine, containing saccharine and mucilaginous matter, the precipitation takes place very slowly; the particles are excessively minute, and become entangled with the mucilage, etc., and thus remain suspended for a long time, maintaining the turbidity accordingly.

Now, this bitartrate of potash is the characteristic natural salt of the grape, and its unfermented juice is saturated with it. As fermentation proceeds, and the sugar of the grape-juice is converted into alcohol, the capacity of the juice for holding the salt in solution diminishes, and it is gradually thrown down. But it does not fall alone. It carries with it some of the coloring and extractive matter of the grape-juice. This precipitate, in its crude state called *argol*, or *roher Weinstein*, is the source from which we obtain the tartaric acid of commerce, the cream of tartar, and other salts of tartaric acid.

Now let us suppose that we have a natural, unsophisticated wine. It is evident that it is saturated with the tartrate, since only so much argol was thrown down during fermentation as it was unable to retain. It is further evident that if such a wine has not been exhaustively fermented, i. e., still contains some of the original grape-sugar, and, if any further fermentation of this sugar takes place, the capacity of the mixture for holding the tartrate in solution becomes diminished, and a further precipitation must occur. This precipitation will come down very slowly, will consist not merely of pure crystals of cream of tartar, but of minute particles carrying with it some coloring-matter, extractives, etc., and thus spoiling the brilliancy of the wine, making it more or less turbid.

But this is not all. Boiling water dissolves $\frac{1}{6}$ of its weight of cream of tartar, cold water only $\frac{1}{180}$, and, at intermediate temperatures, intermediate quantities. Therefore, if we lower the temperature of a saturated solution, precipitation occurs. Hence, the sickening of wine due to change of cellars or change of climate, even when no further fermentation occurs. The lighter the wine, i. e., the less alcohol it con-

tains naturally, the more tartrate it contains, and the greater the liability to this source of sickness.

This, then, is the temporary sickness to which I have referred. I have proved the truth of this theory by filtering such sickened wine through laboratory filtering paper, thereby rendering it transparent, and obtaining on the paper all the guilty disturbing matter. I found it to be a kind of argol, but containing a much larger proportion of extractive and coloring matter, and a smaller proportion of tartrate, than the argol of commerce. I operated upon rich new Catalan wine.

This brings me at once to the source or origin of a sort of wine-cookery by no means so legitimate as the Pasteuring already described, as it frequently amounts to serious adulteration.

The wine merchants are here the victims of their customers, who demand an amount of transparency that is simply impossible as a permanent condition of unsophisticated grape-wine. To anybody who has any knowledge of the chemistry of wine, nothing can be more ludicrous than the antics of the pretending connoisseur of wine who holds his glass up to the light, shuts one eye (even at the stage before double vision commences), and admires the brilliancy of the liquid, this very brilliancy being, in nineteen samples out of twenty, the evidence of adulteration, cookery, or sophistication of some kind. Genuine wine made from pure grape-juice without chemical manipulation is a liquid that is never reliably clear, for the reasons above stated. Partial precipitation, sufficient to produce opalescence, is continually taking place, and therefore the brilliancy demanded is obtained by substituting the natural and wholesome tartrate by salts of mineral acids, and even by the free mineral acid itself. At one time I deemed this latter adulteration impossible, but have been convinced by direct examination of samples of *high-priced* (mark this, not *cheap*) dry sherries that they contained free sulphuric and sulphurous acid.

The action of this free mineral acid on the wine will be understood by what I have already explained concerning the solubility of the bitartrate of potash. This solubility is greatly increased by a little of such acid, and therefore the transparency of the wine is by such addition rendered stable, unaffected by changes of temperature.

But what is the effect of such mineral acid on the drinker of the wine? If he is in any degree predisposed to gout, rheumatism, stone, or any of the lithic-acid diseases, his life is sacrificed, with preceding tortures of the most horrible kind. It has been stated, and probably with truth, that the late Emperor Napoleon III drank dry sherry, and was a martyr of this kind. I repeat emphatically that high-priced dry sherries are far worse than cheap Marsala, both as regards the quantity they contain of sulphates and free acid.

Anybody who doubts this may convince himself by simply purchasing a little chloride of barium, dissolving it in distilled water, and adding to the sample of wine to be tested a few drops of this solution.

Pure wine, containing its full supply of natural tartrate, will become cloudy to a small extent, and gradually. A small precipitate will be formed by the tartrate. The wine that contains either free sulphuric acid or any of its compounds will yield *immediately* a copious white precipitate like chalk, but much more dense. This is sulphate of baryta. The experiment may be made in a common wine-glass, but better in a cylindrical test-tube, as, by using in this a fixed quantity in each experiment, a rough notion of the relative quantity of sulphate may be formed by the depth of the white layer after all has come down. To determine this *accurately*, the wine, after applying the test, should be filtered through proper filtering-paper, and the precipitate and paper burned in a platinum or porcelain crucible and then weighed; but this demands apparatus not always available, and some technical skill. The simple demonstration of the copious precipitation is instructive, and those of my readers who are practical chemists, but have not yet applied this test to such wines, will be astonished, as I was, at the amount of precipitation.

I may add that my first experience was upon a sample of dry sherry, brought to me by a friend who bought his wine of a most respectable wine-merchant, and paid a high price for it, but found that it disagreed with him; since that I have tested scores of samples, some of the finest in the market, sent to me by a thoroughly conscientious importer as the best he could obtain, and these contained sulphate of potash instead of bitartrate.

My friend, the sherry-merchant, could not account for it, though he was most anxious to do so. This was about three years ago. By dint of inquiry and cross-examination of experts in the wine-trade, I have, I believe, discovered the origin of the sulphate of potash that is contained in the samples that the British wine-merchant sells as he buys, and conscientiously believes to be pure. I will state particulars in my next.

XLV.—COCOA AND THE COOKERY OF WINE.

A correspondent writes to the editor asking whether I class cocoa among the stimulants. So far as I am able to learn, it should not be so classed, but I can not speak absolutely. Mere chemistry supplies no answer to this question. It is purely a physiological subject, to be studied by observation of effects. Such observations may be made by anybody whose system has not become "tolerant" of the substance in question. My own experience of cocoa in all its forms is that it is not stimulating in any sensible degree. I have acquired no habit of using it, and yet I can enjoy a rich cup or bowl of cocoa or chocolate just before bed-time without losing any sleep. When I am occasionally betrayed into taking a late cup of coffee or tea, I repent it for some hours after going to bed. My inquiries among other people, who are not under the influence of that most powerful of all arguments, the logic of inclination, have confirmed my own experience.

I should, however, add that some authorities have attributed exhilarating properties to the *theobromine* or nitrogenous alkaloid of cocoa. Its composition nearly resembles that of theine, as the following (from Johnstone) shows:

	Theine.	Theobromine.
Carbon	49·80	46·43
Hydrogen	5·08	4·20
Nitrogen	28·83	35·85
Oxygen	16·29	13·52
Total	100·000	100·000

It exists in the cocoa-bean in about the same proportion as the theine in tea, but in making a cup of cocoa we use a much greater weight of cocoa than of tea in a cup of tea. If, therefore, the properties of theobromine were similar to those of theine, we should feel the stimulating effects much more decidedly.

The alkaloid of tea and coffee in its pure state has been administered to animals, and found to produce paralysis, but I am not aware that theobromine has acted similarly.

Another essential difference between cocoa and tea or coffee is that cocoa is, strictly speaking, a food. We do not merely make an infusion of the cacao-bean, but eat it bodily in the form of a soup. It is highly nutritious, one of the most nutritious foods in common use. When traveling on foot in mountainous and other regions, where there was a risk of spending the night *al fresco* and supperless, I have usually carried a cake of chocolate in my knapsack, as the most portable and unchangeable form of concentrated nutriment, and have found it most valuable. On one occasion I went astray on the Kjolenfjeld, in Norway, and struggled for about twenty-four hours without food or shelter. I had no chocolate then, and sorely repented my improvidence. Many other pedestrians have tried chocolate in like manner, and all I know have commended its great "staying" properties, simply regarded as food. I therefore conclude that Linnæus was not without strong justification in giving it the name of *theobroma* (food for the gods), but to confirm this practically the pure nut, the whole nut, and nothing but the nut (excepting the milk and sugar added by the consumer), should be used. Some miserable counterfeits are offered —farinaceous paste, flavored with cocoa and sugar. The best sample I have been able to procure is the ship cocoa prepared for the navy. This is nothing but the whole nut unsweetened, ground, and crushed to an impalpable paste. It requires a little boiling, and when milk alone is used, with due proportion of sugar, it is a *theobroma.* Condensed milk diluted and without further sweetening may be used.

In my last I promised the results of my investigations concerning the source of the sulphate of potash that I found replacing the natural tartrate in so many samples of sherry.

At first I hunted up all the information I could obtain from books

concerning the manufacture of sherry, and learned that the grapes are usually sprinkled with a little powdered sulphur as they are placed in the vats prior to stamping. The quantity thus added, however, is quite insufficient to account for the sulphur compounds in the samples of wine I examined. Another source is described in the books—that from the sulphuring the casks. This process consists simply of burning sulphur inside a partially-filled or empty cask, until the exhaustion of free oxygen and its replacement by sulphurous acid renders further combustion impossible. The cask is then filled with the wine. This would add a little of sulphurous acid, but still not sufficient.

Then comes the "plastering," or intentional addition of gypsum (plaster of Paris). This, if largely carried out, is sufficient to explain the complete conversion of the natural tartrates into sulphates of potash, but such plastering is admitted to be an adulteration or sophistication, and the best makers deny their use of it. I obtained samples of sherry from a reliable source, which I have no doubt the shipper honestly believed to have been subjected to no such deliberate plastering; still, from these came down an extravagantly excessive precipitate on the addition of chloride-of-barium solution.

At last I learned that "Spanish earth" was used in the fining. Why Spanish earth in preference to isinglass or white of egg, which are quite unobjectionable and very efficient? To this question I could get no satisfactory answer directly, but learned vaguely that the fining produced by the white of egg, though complete at the time, was not permanent, while that effected by Spanish earth, containing much sulphate of lime, is permanent. The brilliancy thus obtained is not lost by age or variations of temperature, and the dry sherries thus cooked are preferred by English wine-drinkers.

Here, then, is a solution of the mystery. The sulphate of potash which is thus made to replace bitartrate is so readily soluble that neither changes of temperature nor increase of alcohol, due to further fermentation, will throw it down; and thus the wine-merchant, without any guilty intent, and ignorant of what he is really doing, sophisticates the wine, alters its essential composition, and adds an impurity in doing what he supposes to be a mere clarification or removal of impurities.

I have heard of genuine sherries being returned as bad to the shipper because they were genuine, and had been fined without sophistication. Are we to blame the wine-merchant for this? I think not.

My own experience of genuine wines in wine-growing countries teaches me that such wines are rarely brilliant; and the variations of solubility of the natural salt of the grape, which I have already explained, shows why this is the case. If the drinkers of sherry and other white and golden wines would cease to demand the conventional brilliancy, they would soon be supplied with the genuine article, which really costs the wine-merchant less than the cooked product they now

insist upon having. This foolish demand of his customers merely gives him a large amount of unnecessary trouble.

So far, the wine-merchant; but how about the consumer? Simply that the substitution of a mineral acid—the sulphuric for a vegetable acid (the tartaric)—supplies him with a precipitant of lithic acid in his own body; that is, provides him with the source of gout, rheumatism, gravel, stone, etc., with which *English* wine-drinkers are proverbially tortured.

I am the more urgent in propounding this view of the subject because I see plainly that not only the patients, but too commonly their medical advisers, do not understand it. When I was in the midst of these experiments I called upon a clerical neighbor, and found him in his study with his foot on a pillow, and groaning with gout. A decanter of pale, choice, very dry sherry was on the table. He poured out a glass for me and another for himself. I tasted it, and then perpetrated the unheard-of rudeness of denouncing the wine for which my host had paid so high a price. He knew a little chemistry, and I accordingly went home forthwith, brought back some chloride of barium, added it to his choice sherry, and showed him a precipitate which made him shudder. He drank no more dry sherry, and has had no serious relapse of gout.

In this case his medical adviser prohibited port and advised dry sherry.

The following from "The Brewer, Distiller, and Wine Manufacturer," by John Gardner (Churchill's "Technological Handbooks," 1883), supports my view of the position of the wine-maker and wine-merchant: "Dupré and Thudicum have shown by experiment that this practice of plastering, as it is called, also reduces the yield of the liquid, as a considerable part of the wine mechanically combines with the gypsum and is lost." When an adulteration—justly so called—is practiced, the object is to enable the perpetrator to obtain an increased profit on selling the commodity at a given price. In this case an opposite result is obtained. The gypsum, or Spanish earth, is used in considerable quantity, and leaves a bulky residuum, which carries away some of the wine with it, and thus increases the cost to the seller of the salable result.

Having referred so often to dry wines, I should explain the chemistry of this so-called dryness. The fermentation of wine is the result of a vegetable growth, that of the yeast, a microscopic fungus (*Pencillium glaucum*). The must, or juice of the grape, obtains the germ spontaneously—probably from the atmosphere. Two distinct effects are produced by this fermentation or growth of fungus: first, the sugar of the must is converted into alcohol; second, more or less of the albuminous or nitrogenous matter of the must is consumed as food by the fungus. If uninterrupted, this fermentation goes on either until the supply of sufficient sugar is stopped, or until the sup-

ply of sufficient albuminous matter is stopped. The relative proportions of these determine which of the two shall be first exhausted.

If the sugar is exhausted before the nitrogenous food of the fungus, a dry wine is produced; if the nitrogenous food is first consumed, the remaining unfermented sugar produces a sweet wine. If the sugar is greatly in excess, a *vin de liqueur* is the result, such as the Frontignac, Lunel, Rivesaltes, etc., made from the Muscat grape.

The varieties of grape are very numerous. Rusby, in his "Visit to the Vineyards of Spain and France," gives a list of five hundred and seventy varieties, and as far back as 1827 Cavalow enumerated more than fifteen hundred different wines in France alone.

From the above it will be understood that, *cæteris paribus*, the poorer the grape the drier the wine; or that a given variety of grape will yield a drier wine if grown where it ripens imperfectly, than if grown in a warmer climate. But the quantity of wine obtainable from a given acreage in the cooler climate is less than where the sun is more effective, and thus the *naturally* dry wines cost more to produce than the *naturally* sweet wines.

This has promoted a special cookery or artificial drying, the mysteries of which will be discussed in my next.

SICK-RATES AND DEATH-RATES.

By CL. T. CAMPBELL, M. D.

THE operations of benefit societies ought to provide a fruitful field for investigation by the student of vital statistics. These organizations, embracing a very large membership, deal practically with the accidents of sickness and of death, and can be made to supply valuable data. In Great Britain this has been done, and can be done, with comparative ease. The laws of that country take direct cognizance of benefit societies, and require from them statistical reports of their work, which are tabulated and published by authority. The latest available report of the British Registrar of friendly societies mentions no fewer than 15,379 branches of different organizations of this kind; of which number 12,300, embracing a membership of 4,672,175, had sent the required returns. The experience of so large a number of persons should certainly be of value. And we find that it has been utilized to a considerable extent, for from these returns tables of the expectation of sickness and death have been prepared by a number of English statisticians, including Ratcliffe, Finlaison, and others.

On this continent information concerning the operations of these societies can be obtained only from such reports as they publish themselves. They are not under Government supervision; and their sta-

tistics are not available for purposes of comparison without considerable labor on the part of the inquirer.

As a contribution to this subject, I propose giving the experience of the oldest, and, I believe, the largest, benefit society in North America, that of the Odd-Fellows, which has been in operation sixty-four years, and has a membership of about half a million. Though the society has branches in South America, Australia, Germany, and other places, yet the statistics I shall give will be confined to the membership in the United States and Canada—two countries whose circumstances of race, climate, and social customs are similar.

The membership of the Society of Odd-Fellows is confined to healthy white males, of the age of twenty-one and upward. When I say "healthy," I mean approximately so. In some localities a medical certificate of good health is required from every candidate for membership; and in all cases *prima facie* evidence of sound physical condition is a necessary prerequisite for admission. While, therefore, the society may not consist of lives as carefully selected as the policy-holders of an insurance company, yet they constitute a fair average of the healthy male adults of the Caucasian race. And any possible inferiority to life-insurance subjects in the matter of physical health will be more than balanced by the advantages resulting from the comparatively high standard of morals necessary to membership in a benevolent and moral organization.

The death-rate of this society for the last nine years has been as follows:

YEAR.	Members.	Deaths.	Average.	YEAR.	Members.	Deaths.	Average.
1873........	414,815	4,013	·0096	1878........	442,291	4,381	·0099
1874........	438,701	3,889	·0088	1879........	440,783	4,530	·0102
1875........	454,689	4,543	·0099	1880........	456,942	4,504	·0098
1876........	456,125	4,317	·0094	1881........	475,948	5,055	·0106
1877........	448,019	4,284	·0095				

The average rate for the period embraced in this table appears from these figures to be less than one in 100 (.0097). But the returns come from a very large section of country, with varying conditions, geographical and social, which may materially affect the mortality in special localities. It will be advisable, therefore, to individualize more closely. For convenience, we will classify the several States and Provinces into five groups. We will let the Eastern group embrace Connecticut, Delaware, Massachusetts, Maine, Maritime Provinces of Canada, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; the Northern—Dakota, Manitoba, Michigan, Minnesota, Montana, Ontario, Quebec, Wisconsin, and Wyoming; the Central—Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Nebraska, Ohio, and West Virginia; the Southern—Alabama, Arkansas, Florida, Georgia, Louisiana, Maryland, Mississippi,

New Mexico, North Carolina, South Carolina, Tennessee, Texas, and Virginia; the Western—Arizona, British Columbia, California, Nevada, Oregon, and Washington. This is a somewhat arbitrary division, but it will serve the purpose.

Taking the statistics of 1881, we find the membership, deaths, and rate per 100 in these several groups to have been as follows:

LOCALITY.	Members.	Deaths.	Rate.
Eastern	196,558	2,290	1·11
Northern	50,350	400	·70
Central	165,473	1,552	·95
Southern	34,781	495	1·42
Western	28,523	309	1·08
Total	475,685	5,046	1·06

The apparent conclusion from this table would be that, while in the Eastern, Central, and Western sections the rate did not range very far from the general average, in the Northern it was very much below, and in the Southern very much above. Is this variation characteristic of the localities, or is it due to some special feature of the membership whose experience is tabulated? We find that in the Northern group of States and Provinces the rate is about thirty per cent below the average. But in this section the society is comparatively young; many of its branches have only been in existence a few years; and the membership is composed largely of men in the prime of life, or of those who have but recently passed some test of physical soundness. This might account for the lower rate of mortality. In the Southern section, while there are quite a few old branches, yet in many parts they are as young as in the North—the society having, like all others, suffered by the civil war, and having begun anew during the last fifteen years. We might reasonably expect, therefore, that the rate in the South, though above the average reported, is yet below the actual rate of the locality.

In order to obtain the true death-rate of the average adult male population, it is necessary to confine our investigations, if possible, to those branches which have been in existence for at least the life of one generation; and which will, therefore, contain their just proportion of aged persons. For the year 1881 the statistics were collected of 425 branches in different States, which had been in existence for not less than thirty-five years. In these, with a membership of 51,452, there were 655 deaths, or 1·27 per 100.

It is not possible from the returns to give anything like a correct average for each State or province, or even for each of the groups previously defined. In some States the membership of the older lodges is too small to give results that could form the basis of a correct estimate; but, by grouping some of the States in a geographical classification, we may calculate the average of certain sections. Thus

the Southern States of Alabama, Arkansas, Georgia, Louisiana, South Carolina, and Tennessee have an average of 2·9 per 100; the Eastern States of Maine, Massachusetts, New Jersey, Rhode Island, and Vermont have an average of 1·1; the Central States of Illinois, Indiana, Michigan, Ohio, and Wisconsin, also 1·1; in the Pacific States the society is not thirty-five years old, so that no statistics are obtainable from that quarter; while from other sections the returns were not in a shape to supply the requisite data. But enough was obtainable to show that on the most favorable estimate in tropical States the death-rate is twice as high as in the temperate zone.

Making due allowance for the failure of any of the subordinate officials to send complete returns of their deaths, it is a fair conclusion from such statistics as are available that the average death-rate of the better class of the adult male population of this continent is for the temperate regions 1·5 in every 100; and for the tropical regions three in every 100.

But it is in the matter of sickness that the vital statistics of the United States and Canada have hitherto been most deficient; and in this connection the operations of a large society making weekly payments to its sick members, and thus keeping some record of the amount of sickness experienced by them, can be made useful.

The returns available here, it must be noted, do not give the full sickness experience. Reports are made only of the number of weeks for which sick-benefits are paid. Usually a person must be a member a certain length of time, from one to six months, before he is entitled to benefits; in some localities no benefits are paid for the first week of sickness; members who are in arrears to the society receive no benefits. So that the actual average of sickness will be somewhat in advance of the figures given.

Taking the entire society in the United States and Canada, we find the following returns for the last seven years:

YEAR.	Members.	Weeks' benefits paid.	Average.	YEAR.	Members.	Weeks' benefits paid.	Average.
1875........	454,689	211,148	·4667	1879........	440,783	246,768	·5959
1876........	456,125	230,398	·5160	1880........	456,942	251,448	·5502
1877........	448,019	221,319	·4939	1881........	475,948	285,081	·5989
1878........	442,291	237,709	·5368				

Submitting these returns to the same system of grouping that we adopted with the mortality returns, we have the following result:

LOCALITY.	Members.	Weeks' sickness.	Per member.
Eastern	196,558	148,311	·754
Northern	50,350	13,446	·266
Central........................	165,473	72,667	·439
Southern	34,781	32,417	·946
Western	28,523	18,967	·665

A noticeable feature of this table is that the death-rate and sick-rate bear a close relationship in the several localities. To make it more apparent, we place them in parallel columns:

LOCALITY.	Deaths in 100.	Weeks' sickness per member.
Northern	·70	·266
Central..........................	·90	·439
Western..........................	1·08	·665
Eastern	1·11	·754
Southern	1·42	·946

In order to obtain, however, the average for the general population, we turn to the older branches, with the following results: For 1881, there were 655 branches over thirty-five years old, reporting 83,121 members, with 79,902 weeks' sickness—being an average of ·961 of a week. We find that the Eastern section, with 60,783 members, reports 63,295 weeks' sickness, or an average of 1·041; and the Central reports 15,839 members and 13,211 weeks—an average of ·834. The returns from the Northern and Southern States are insufficient for a fair comparison; but the fact that one State alone, Maryland, with a membership of 10,785, reports 21,259 weeks' sickness, is an evident indication that there is the same proportionate advance in the rate in every locality.

Judging from the experience of this society, it is a reasonable conclusion that the average sickness of the better class of the adult male population of the United States and Canada is one week and a half each year.

But a more important calculation, which can be made from the statistics of benefit societies, is the expectation of sickness for each year of a person's life. This has been computed in England by several actuaries. While they have not agreed entirely in details, for the simple reason that they have taken the experience of different classes of people, yet they have agreed on the general principle that there is a regular increase in the average of yearly sickness with each year of a person's life. The statistics of the Society of Odd-Fellows in America have also been tabulated at different periods during the last thirty years. The first calculations were made in 1854, and were based on the experience of 66,000 persons. The plan adopted for securing the necessary data was to require each subordinate branch to send to the central authorities a return of the number of members at each year of age, of the number sick at each year of age, and of the number of weeks' sickness for each age. This process has been repeated at different periods and in different States. In some States it is done every year.

From the data thus obtained has been compiled a table of the expectation of sickness, which has been published by the authorities of

the society as a basis for the use of the membership in the arrangement of their beneficial system. As this table has never, so far as I know, been published outside the society's own journals, I submit it here, with the expectation of life, according to the American tables:

AGE.	Expectation of life—years and decimals.	Expectation of sickness for that year—weeks and decimals.	AGE.	Expectation of life—years and decimals.	Expectation of sickness for that year - weeks and decimals.
21..........	41·5	·450	41..........	27·4	·763
22..........	40·8	·455	42.........	26·7	·803
23..........	40·2	·460	43..........	26·	·843
24..........	39·5	·465	44..........	25·3	·885
25..........	38·8	·470	45..........	24·5	·930
26..........	38·1	·476	46..........	23 8	·980
27..........	37·4	·483	47..........	23·1	1·035
28..........	36 6	·491	48..........	22·4	1·095
29..........	36·	·499	49..........	21·6	1·166
30..........	35·3	·509	50..	20·9	1·230
31..........	34·6	·520	51..........	20·2	1·308
32..........	33·9	·532	52..........	19·5	1·396
33..........	33·2	·545	53..........	18·8	1·494
34..........	32·5	·560	54..........	18·1	1·604
35..........	31·8	·578	55..........	17·4	1·730
36..........	31·1	·599	56..........	16·7	1·875
37..........	30 3	·624	57..........	16·	2·040
38..........	29·6	·653	58..........	15·4	2·230
39..........	28·9	·686	59..........	14·7	2·450
40..........	28·2	·723	60..........	14·1	2·700

PROPERTIES AND CONSTITUTION OF SEA-WATER.

By M. ANTOINE DE SAPORTA.

IT has been said that, without the sea, civilization could not have been developed, and the world would have continued barbarous. That element, from the primitive times of mankind, has brought together the peoples of the most distant countries, and inspired the ancients with the idea of the Infinite. Homer believed in a river Oceanus; the Hindoo mythologians in a liquid expanse, boundless as space. The fishermen who set their rude nets in the creeks of the Cyclades were, perhaps, the first naturalists, and the Phœnician sailors may have been the first marine engineers. In our own time, all the sciences find in the ocean either a limitless field of exploration, or an enemy to be conquered. Zoölogists, closeted in their laboratories, endeavor to determine the beings which the dredge has brought up from frightful depths, while hydrographers and constructors study the currents, raise jetties, and excavate ports. The public visit the aquariums, admire the dikes and excavations, and applaud what they see, but do not see all. Our purpose is to explain the researches of the

modest investigators who have occupied themselves with the chemical constitution and physical properties of sea-water.

Sea-water, it is well known, when it is not muddy, is one of the clearest of all natural waters. When we walk along the shore at low tide, it is often difficult, unless we are careful, to keep from stepping into the occasional pools on the rocks, the water in the little hollows being so transparent as to be invisible. The question of the color of this water deserves serious examination, and labors on the subject are not wanting. The most notable ones are those of Father Secchi, of Professor Tyndall, and the more recent researches of M. W. Spring and M. Soret.

Father Secchi made his experiments in 1865, on board a Pontifical corvette. A number of disks, formed by stretching variously-colored cloths over iron hoops, the largest twelve feet in diameter, were let down at a time when the conditions of the weather were most favorable for transparency. The largest disk, which was painted white, became invisible at the depth of about forty-two metres, while the smaller disks and a delf plate, distorted by refraction, went out of sight at smaller depths. The disappearance seemed to depend upon the confusion of the image, which was broken up in every direction. The largest disk, the considerable surface of which offered more resistance to the distortion, finally ceased to be perceived, because its color, turning in succession to light green, blue, and dark blue, became at last as dark as the surrounding medium. Disks, painted yellow or red, were lost to sight still more quickly, or under not more than twenty metres of water. Repetitions of similar experiments gave co-ordinate results; and it may be stated, as a general rule of average, that the practical limit of submarine vision, under favorable circumstances, is at twenty-five metres under the surface.

It was found, by spectroscopic examinations of the light reflected from the differently colored disks, that the yellow was enfeebled and extinguished first, and next the red, under the increasing thickness of the overlying water. By the gradual disappearance of these two colors, a white object is made to pass through green to blue—the tint which all such objects finally assume when sunk under salt-water. Each of the three simple colors—yellow, red, and blue, or violet—has its distinct part among the solar rays. Yellow is luminous, red is calorific, and violet-blue provokes chemical reactions. Water, in a very thick mass, is neither transparent nor diathermanous; but, being penetrable to the blue, indigo, and violet rays, it is diactinic. These radiations, too, will, of course, gradually lose their energy, and become extinguished at last in a very deep stratum of liquid; but the limit is extremely remote.

According to the theory propounded by Professor Tyndall, the sea-waves present three principal hues—blue, green, and yellow. The indigo-blue waters are the purest, while the yellow ones contain muddy

matters in suspension, and the green ones are slightly charged with such substances. The solid particles held in the water constitute a multitude of infinitely little mirrors, from the outside of which is reflected the light that penetrates the mass of the liquid. The rays which are sent out, after having traversed only a thin stratum of water, preserve their yellow parts. If the reflections are attenuated, the water appears green ; and if, on account of the absence of solid matter, they do not exist at all, the sea is of a deep blue. In an indigo sea, the crests of the waves will appear green on account of their lack of thickness. The same rules are applicable to fresh water ; for the salt is almost without effect on the color of sea-water—not quite without effect, for, according to M. Spring, the clayey particles which make the waves yellow are precipitated with a rapidity proportioned to the salinity of the sea. These general laws are liable to be disturbed by numerous accidental circumstances or local causes. The presence of sea-weed, or of microscopic animalcules, may have great influence on the color of the water. In tolerably shallow basins, the color of the bottom has its effect.

Several seas or gulfs have been given names alluding to their colors. Some of these terms can be explained without difficulty, but others are not so easy to comprehend. The White Sea is so called on account of its ice, the Black Sea from its storms, and the Yellow Sea from the muddy waters poured into it by the Chinese rivers. The waves of the Vermilion Sea, near California, are colored by the Rio Colorado, which itself has a characteristic name. The water that washes the European coasts has no perceptible odor ; or, if in single cases it may be odorous, the smell is due to mud, or to decomposing organic matters contained it it. Drinking-water, which is stored for some time may also acquire a smell which it had not at first, through the decay of the impurities in it. The cork of bottles containing salt-water is sometimes eaten by sulphuretted hydrogen formed in the water.

Sea-water owes its characteristic taste to the chloride of sodium held in solution, and to the bitter salts of magnesia which it contains. Sometimes organic remains or weak proportions of fatty matters become mixed with the superficial strata, so as to make them more nauseous than the same water drawn from greater depths. The pleasant taste of the water inclosed in oyster-shells is due to the savory animal juices that are dissolved in it. Mussels, which live and are fished near the shore, sometimes absorb impurities from the drift-matter around them, from which they develop the poisonous alkaloids called *ptomaïnes ;* hence they are unhealthy at some seasons.

By a scientific prejudice that ruled for a considerable time, the bitter taste of sea-water was believed to be caused by traces of bitumen. The chemists who made analyses consoled themselves for not finding a sign of that substance, the existence of which they suspected, by sup-

posing the proportion was too slight to be appreciable. Count Marsigli, who in the reign of Louis XIV tried to make sea-water artificially, took great pains to mix bitumen with the salts he put in solution, in order to make the reproduction perfect. The partisans of the theory cited the Dead Sea, which was near asphalt-beds, and the waters of which were insupportably bitter. But Macquer, assisted by Lavoisier, a hundred years ago, carefully distilled specimens of this water, and found in it no more bitumen than had been found in Mediterranean water—which was none at all. He attributed the bitter taste of this water to the presence of salts of magnesia.

It is not to-day that investigators have sought to make sea-water potable by removing its nauseous taste. The problem was solved long ago, and, as often happens, the usefulness of the invention once so greatly desired has been much depreciated. When fresh water for the provisioning of vessels was stored in wooden casks, it was liable to spoil in a short time. Now it is carried in large iron tanks, in which, instead of spoiling, it is improved by acquiring a ferruginous quality. The ancients did not venture far from the shores, and were contented with a simple coasting-trade; nevertheless, this question interested them, and Pliny describes two means of freshening the water of the Mediterranean, one of which is absurd and the other impracticable: One was to plunge into the sea hollow balls of wax, which, the author affirms, would be filled with pure water; and the other was to expose fleecy sheep-skins on the deck of the vessel, to collect the morning dews.

Whoever examines the series of memoirs published during the seventeenth and eighteenth centuries, on the subject of freshening sea-water by distillation, must be struck by the divergence of opinions and the want of concordance in the results, some declaring that distilled water is pure, healthy, and tasteless, others that it is unhealthy and almost as detestable as before the operation. The differences between them are easily explained. Marine salt is not the only substance dissolved in the water, but is accompanied by several other bodies, the principal of which is chloride of magnesium. This salt when dry resists the action of the most violent heat without changing; but in boiling water undergoes a double decomposition, in which the chlorine leaves the magnesium to unite with the hydrogen of the water, while the oxygen thereof unites with the magnesium. There is thereby produced magnesia, which remains in the vessel, and hydrochloric acid, which is distilled over. Now, distilled water is made impotable and unhealthy by any traces of that acid. The difficulty may be obviated by previously removing such salts as can be made to settle, or by adding fresh sea-water. Water boils at a temperature several degrees higher than usual when it is charged with salts. If it is sufficiently diluted it will not disengage hydrochloric acid. Or the acid may be absorbed by substances added to the water for that purpose, and which

will not give it up again. Such substances are lime, chalk, potash, soda, and calcined bones, all common and cheap.

The problem of freshening sea-water was formerly regarded as so important that other means of solving it besides that of evaporation were advanced. Even the great Leibnitz lent his name to a proposition which was judged singular, if nothing worse, by his contemporaries. It was to freshen water by forcing it through a filter filled with litharge; but he never tried the experiment. It was believed, on the authority of Pliny, that if an empty bottle, hermetically sealed, were sent down deep into the ocean, it would come back full of pure water. But it was proved that the bottles would either be broken or come back empty. Other naturalists tried filters of earth or sand. But, when Réaumur and the Abbé Nollet constructed a gigantic filter of glass tubes filled with sand, a thousand toises long, they found that the water came out of it as salt as it went in. Lister, in 1684, placed sea-weeds with their stems in water, after the fashion of a bunch of flowers, in an alembic which he did not heat, believing that the fresh water would ooze out in drops from the upper part of the plants; but he had to acknowledge that no great result came from his curious process. Samuel Reyer made a discovery of some practical value—that melted sea-ice furnished a potable water. Notwithstanding numerous distilling apparatus were devised by various inventors, ships continued to be furnished until very recently with water stored in casks. The inventions had little practical value, and the management of alembics when the sea was rough was a matter of considerable difficulty.

The sea is in reality an immense and inexhaustible mineral spring. Probably, if it only contained pure water, a fountain as rich in mineral matters as the ocean actually is would attract crowds of drinkers and would be recommended for internal use in all imaginable diseases. But sea-water is abundant and common, and has never been much used internally. On the other hand, the therapeutic employment of sea-baths might be made the occasion of long dissertations.

It is generally known that a strong dose of sea-water acts as an emetic; in weaker proportions it is purgative and diuretic. Dioscorides advised diluting it with honey, which might, perhaps, produce an efficacious medicine, but certainly not a savory one. At the beginning of this century it was diluted with wine, but such a mixture could hardly be better than the other one. It was prescribed in Spain against the yellow fever, and in England against worms: in the former case, as an emetic; in the second case, milk was added to it so that the child could drink it without aversion. Sea-baths have been tried as remedies for hydrophobia and insanity, but, it is needless to say, without effect.

Marine water contains a little iodine; it is therefore a resolvent, and adapted to external application for tumors and ulcers, although more

energetic and sure remedies are generally employed. Even before iodine was discovered, more than a hundred years ago, Russel had remarked the efficacy of calcined sponges and corals, and of the ashes of sea-weed, substances richer in iodine than sea-water itself.

A general study of the physical properties of sea-water would not be complete if it was limited to that at the surface. It is necessary to obtain specimens drawn from different depths, especially as the density and temperature vary with the depth. Various apparatus have been contrived for bringing to the surface a quantity of water drawn from any desired level. A long-known means, and at the same time a simple and practicable one, is to let down by a rope an empty bottle corked. The increasing pressure upon the bottle becomes strong enough at certain depths to push the cork in and fill the bottle. The rope is then drawn up, and the liquid inside the bottle coming in contact with less dense waters, pushes the cork back into the neck of the bottle and closes it. Thus the water from the deep keeps itself free from mixture with that of the superficial levels. Other more perfect apparatus have been invented, all dependent upon the automatic closing of the vessels.

Salt water is denser than fresh, because of the gravity of the dissolved salts. But wherever large rivers enter the sea, as in the Black Sea and the Baltic, and in cold climates where evaporation is slow, the superficial water is light and of inferior salinity. The water of the Norwegian fiords is brackish, and that of the Gulf of Bothnia, at the upper end of the Baltic, is, in an extremity, potable. The glaciers of Greenland and Spitzbergen pour out in the summer torrents of fresh water which tend to freshen the spaces around their mouths. There is likewise a deficiency of salt in the waters of the White Sea, the Kara Sea, and the Siberian Ocean. Inversely, the Mediterranean, which does not receive, in proportion to its extent, so many nor so large rivers, and is exposed to the ardors of a burning sun, would become indefinitely concentrated by evaporation, were it not that an under-current of less dense water was sent into it by the Atlantic Ocean through the Strait of Gibraltar. Copious rains may play some part in the matter, and that is another reason why Mediterranean waters should preserve their density. Evaporation is very great in the tropics, but the liquid concentrated by it is also expanded by the heat, so that the two effects partly balance one another.

In all the old books on the physics of the globe, and even in some recent ones, no difference was made as to the law of maximum density between salt water and fresh. The latter begins to expand by heat at 4° C. (39° Fahr.), but, between the freezing-point and that temperature, it contracts when it is warmed, so that at 39° Fahr. it is denser than at any other temperature. In temperate countries, the water of the bottom of deep lakes remains at nearly 39° Fahr. by means of its weight, which prevents it from rising to the surface and

mixing with either the colder or the warmer parts, and also because water conducts heat very badly.

The phenomena are different in the case of sea-water, and also complicated in other ways. The point of maximum density descends as the weight of the salt-water and its richness in dissolved matter increase. The Swedish chemist and hydrographer, Ekman, after long series of experiments relative to this question, has found that this critical temperature may fall to —4° C. (25° Fahr.) in Atlantic water. The properties of a brackish fluid, such as would be drawn from a fiord, would naturally be intermediate between those of a pure and those of a very salt water. Hence the depths of the ocean can not be at 39° Fahr., as some authors still maintain. A slight excess of salt in solution will weight a stratum of water of mean temperature, whereby a cold zone may be superposed upon another zone which is warmer but more saline. The interior of the ocean, as well as its surface, is plowed by numerous currents, some warm, some cold, which meet, mix, and separate again, so that it is very hard to find out by reasoning what experiment alone can teach. A similar variety is shown in the density of water brought up by soundings. The complication is magnified when we reflect that water is not absolutely incompressible, that each thickness of ten metres exercises a vertical pressure nearly equal to an atmosphere, the action of which added to that of the superior parts weighs upon the inferior liquid, so that at about 4,000 metres the pressure is 400 atmospheres. Water must be extremely dense when it it compressed with so much force, and the influence of salinity and temperature must become very small in these unfathomable abysses. The question of submarine temperatures has given rise to many controversies. Some, with Perron, suppose that the great depths are always cold, like the tops of the highest mountains. On the other extreme, the author of "Epochs of Nature" attributed to the oceanic depths a high temperature on account of their nearness to the central fire. Denis de Montfort and Humboldt are of the opinion that below the superficial parts there prevails a constant temperature, peculiar to each station, and corresponding with the mean annual temperature of the place. This view is correct for regions where the depth is not very great, and in certain bodies of water.

The sea, on account of its great specific heat and its feeble conducting power, plays the part of a moderator of temperature something like that of the fly-wheel of an engine as a moderator of force. In winter it is warmer, in summer it is cooler, than the ambient air, and the difference is emphasized the farther we get away from the shore.

In "The Clouds" of Aristophanes, Strepsiades refuses to pay his creditors who hold that the level of the sea is fixed, believing that, as it receives all the water, it must continue to rise indefinitely. The phenomena of evaporation were not very well understood at that time. Even in the seventeenth century, Father Fournier talked of subterra-

nean fissures or crevasses in which the waters of the Baltic and the Mediterranean, incessantly swelled by the rivers and by the currents of the Sund and of the Strait of Gibraltar, constantly lost themselves. During the last three years, the question of the evaporation of sea-water has been much discussed between the partisans of the Saharian sea and their adversaries. The great point was to ascertain whether the proposed sea would not in the end become an enormous marsh. The sub-commission of the French Academy of Sciences was of the opinion that, other things being equal, salt water would evaporate less rapidly than fresh. Experiments by M. Dieulefait, on the other hand, indicated that a nearly equal loss would occur in the case of salt water and of fresh.

Fresh water freezes at 32° Fahr., but a liquid charged with salt congeals at lower temperatures ; the rule is about the same as for the maximum of density, except that water slightly salt undergoes its contraction before being converted into ice, while normal sea-water acquires its minimum volume only in a state of surfusion, or when maintained artificially in a fluid state in capillary tubes. In this condition, a number of substances, water among them, are susceptible of being cooled considerably below their point of congelation and still remaining liquid. In the Baltic and White Seas, the waters of which for some depth are but weakly charged with salt, ice forms on the surface when the surrounding temperature has become low enough, while immediately below are strata more dense and relatively warmer. But suppose that below a certain depth of a brackish and warm liquid there is a cold salt current ; the latter would produce such a refrigeration in the mixed intermediate strata that a mass of ice would be formed in the interior of the sea at the expense of the less saline zone. The block when formed would rise to the surface by virtue of its specific levity. This is what happens at the mouths of the great Siberian rivers. The Lena, in particular, pours out an enormous mass of warm water which overwhelms the salt waves from the polar regions. Even in the most favorable seasons, the navigator sails in the midst of floating ice-cakes that constitute a constant source of danger, while the thermometer dipped in the sea will indicate a temperature above the freezing-point. The depth of the warm stratum varies with the year, the place, and the prevailing winds ; and hence we account for some explorers declaring impracticable tracks which others have easily sailed over. The northeast passage along the Siberian coast can never become a regular commercial route, unless, by repeated soundings accompanied by attentive studies, we can finally discover regular and periodical laws for the phenomena under consideration.

The Swedish physicist, Edlund, having inquired of the Scandinavian fishermen, was assured that they had sometimes, though rarely, seen the sea near the fiords of their country "vomit fragments of ice." The following is a textual reproduction of the story of one of the sail-

ors concerning this curious and still little-known fact: "Not every year, but times enough, out on the open sea, I have seen ice come rapidly up to the surface. If the weather is calm, we can perceive, as far out as we can see, small cakes in the shape of a plate, coming from the bottom, rise to the surface. The edge is in the air, but, when the upper part of the plate gets above the level of the water, the plate turns over and lies flat upon the liquid. It is a dangerous business, for a boat may thus in a few minutes be surrounded by immense masses of new ice." *

Aside from this anomaly, the formation of isolated blocks of ice in the open sea is very rare. Water of ordinary salinity becomes denser as it cools, for it freezes at about 28° Fahr., and, as we have explained, attains its maximum density at about 35° only if we keep it artificially in the liquid condition. Water that has lost its caloric in contact with the atmosphere soon sinks; sometimes, as Scoresby attests, ice which is formed at medium depth rises to the surface, while sound ing thermometers indicate temperatures near or even below the point of congelation at the bottom. Otto Petterssen is of the opinion that, if water submitted to a cold of a few degrees below its freezing-point does not solidify, it is because immobility favors surfusion, or rather, what is very possible, because we do not know all the laws of nature.

Mr. Petterssen has succeeded by a series of experiments in explaining a variety of phenomena which manifest themselves in the boreal seas, and which Arctic explorers have long been acquainted with, without understanding the reason of them. Sea-water, after its passage to the solid state, has not the same chemical composition as before; but besides this change, which we shall speak of again, it has another interesting peculiarity. If the temperature is very low, the ice of the ocean, like nearly all known bodies, contracts by cold; but at a few degrees below the freezing-point, and before melting, it diminishes in volume when heated, and dilates on cooling. Between 14° Fahr. and — 4°, according to the age and source of the block, there is produced a minimum of density, the mass acquiring its maximum volume—that is, the behavior of the solid is the inverse of that of river-water.

While it contracts by heating at about 18° or 23° Fahr., the ice of salt-water loses some of the properties which it possesses at lower temperature, and which are common to it with ordinary ice. It has no longer the vitreous aspect, the fragility, and the homogeneity of solid ice, but becomes softer, more plastic, and less transparent; its fracture is less distinct, and cracks and holes multiply in it. And, when brackish water congeals, it loses its disagreeable taste, but its bad looks and want of limpidity deprive it of commercial value.

Sea-water is a very complex saline solution; chemical analysis discovers in it halogen radicals, simple, as chlorine and bromine, or com-

* We owe these details to the kindness of M. Otto Petterssen, who has furnished us with many interesting facts, the fruits of his personal observations.

pound, as sulphuric acid and the four basic principles, soda, magnesia, lime, and potash. Chlorine is by far the most abundant principle, and should be credited with more than half the weight of the saline matter. Open any book on chemistry or the physics of the globe, and you will find that sea-water contains, by the litre, so much chloride of sodium, so much sulphate of magnesia, so much chloride of magnesium, etc. These affirmations are wholly hypothetical, for our acquaintance with chemistry is not sufficient to permit such conclusions. Analysis shows that there are in a litre of sea-water so much chlorine, so much sulphuric acid, and so much magnesia, but does not reveal to us how the radicals are united, for the combinations we get in analysis are not probably precisely the ones that existed in the water. We might say that the numerous simple bodies entering into the composition of sea-water are all the time contracting new and incessantly variable alliances, according to the temperature or the concentration of the liquid. It is by intelligently utilizing these laws that they succeed at the salt-works in forcing the mother-waters to deposit at one time cooking-salt, at another time some other combination useful in industry, or which it is desirable to get rid of.

In evaporating to dryness a known quantity of sea-water, under certain precautions, we obtain a residue which, well dried and weighed, furnishes the weight of the total quantity of salts originally dissolved. It is then easy, by a simple calculation, to estimate the proportion of solid substances contained in a litre. Salt-water is denser than fresh water of the same volume and temperature, and this excess of density is evidently proportional to its richness in saline matters. This can be obtained by multiplying the excess of density by 1·32. We may thus replace the chemical operation by a determination of density, an easier experiment, and one that can be made on board ships.

The different oceanic regions are not equally rich in salts. What we have said respecting variations of specific weight shows this very clearly. But, if we always draw the water from a sufficient depth, the variations become much less, as Forchhammer has proved. The figures in his tables oscillate between thirty-four and thirty-five grammes per litre. The relative proportion of the different elements is still more invariable, and we can establish a few slight differences only by taking the means of a large number of estimations. This fixity of relation might have been foreseen, because evaporation concentrates, without taking away an atom of salt, while fresh waters dilute without furnishing any. It follows, then, that the composition of a specimen of sea-water can be estimated with a fair degree of accuracy by ascertaining the proportion of one of its constituents, the chlorine, for instance, and that element is much used as a standard. The amount of chlorine in a litre of liquid collected along the shore diminishes obviously when the ship is approaching ice, or if it is cruising near the mouth of a great river.

When concentrated by any means, sea-water deposits, first, carbonate of lime, next gypsum, or sulphate of lime, and then salt; and, lastly, the salts of magnesia and the bromides. The phenomena are not quite so simple in practice, and the deposits of salt-marshes are rarely composed of a single substance; but we have only intended to indicate the general course of the operation. The salt of commerce is rich in magnesia, or chloride of magnesium, in proportion to the strength of the concentration. Some have even sought to ascribe the enormous deposits of gypsum found in certain regions to ancient seas which, in drying up, deposited that substance among the first.

Potash and the bromides, substances that are relatively little abundant, accumulate in the mother-waters till they become so condensed as to make the industrial working-out of them remunerative. Bromine is less abundant in the Mediterranean than in the waters of the Dead Sea, which may some day become a source of production. Eighteen centuries ago the Romans, according to Pliny, brought to Italy at great expense the water of the Asphaltine Lake, the curative properties of which were held in high esteem. The excess of bromine in this water, however, corresponds exactly with its greater total saltness, so that, except for a few qualifications to which we shall refer again, the relative composition of the dry residue of the Dead Sea is the same as of that from the ocean. In other words, any marine water evaporated to the same degree of density as that of the Dead Sea would be as deleterious to living beings.

Marine ice was formerly regarded as formed of solidified pure water retaining by mechanical adhesion traces of the saline liquid. These traces could be expelled by energetic pressure, when acids and bases would be found in the residue of desiccation in invariable proportions as in the sea. The question of chemical composition of the ice of the Arctic Ocean is complicated in other ways, but it gains in interest what it loses in simplicity. When salt-water is cooled artificially, a small part escapes solidification. The uncongealed residue is insupportably bitter to the taste, and analysis shows that nearly all the magnesia is concentrated in it. The solid block, if it is homogeneous and is not full of holes, and if previously drained, may furnish a passable drink. The natural ices of the Northern Sea are frequently moistened with a kind of brine, which sometimes embodies crystals of special character, easy to distinguish from the ice around them. According to Otto Petterssen, the relative proportions of chlorine and magnesia are much stronger in these exudations than in the water at the expense of which the ice is formed. The liquid can not then have been mechanically absorbed. On the other hand, there is a deficiency of sulphates; and the conclusion that sea-water ice retains the sulphates more abundantly is confirmed by analysis. With congelation, a sorting of matters takes place; most of the sulphuric acid passes into the part that solidifies, while magnesia and chlorine prevail in the part

that remains liquid. Under the influence of variations of temperature, all the chlorides in the block will gradually disappear: some go into the sea and are dissolved; while the rest appear on the surface and form hydrated crystals, or a kind of "salt-snow." The sulphates thus prevail exclusively in old ices, which, according to Mr. Petterssen, constitute mixtures of solidified water and a peculiar chemical compound, the criohydrate of sulphate of soda, a body which, containing five parts of soda to ninety-five of water, is decomposed at a little below the ordinary freezing-point.

By these phenomena of selection, ice, under atmospheric vicissitudes, approaches a limit when its composition would be fixed, without reaching it in reality. Usually, the expulsion of chlorides is not complete, and sudden changes of temperature may liquefy it at once. The Swedish observer compares the ice of salt-water with a kind of granite, each constituent of which should take its turn at decomposing under special circumstances. The warm waters farthest from the pole would bear only the stable constituents brought down by the Arctic current, so that, to continue our comparison, the river, which has gradually eaten away the granite block, finally transports the last remains of the rock in the form of sands and clays, which are destined to accumulate in the sedimentary deposits.

Over and above the substances that exist in considerable proportions, many rarer elements are found in the waters of the ocean; minerals, gases, and organic remains, difficult perhaps to recognize, sometimes impossible to estimate, but which nevertheless play an important part. The phenomena of accumulation which we have considered are absolutely insignificant in comparison with the absorbing power of some of the algæ. In them Courtois discovered iodine in 1812, and Malagutti, after laborious researches, detected copper, lead, silver, and iron, metals which he afterward found in sea-water itself. The quantity of iodine contained is so little appreciable that many doctors have denied the therapeutic virtues which others have attributed to this water. Nevertheless, absorbed and condensed by marine plants, it becomes abundant enough to be extracted with profit. It likewise accumulates in animal organisms; and cod-liver oil owes its beneficent properties to it. The silver was absurdly attributed by Proust to the treasures of shipwrecked vessels. But the quantity, though infinitesimal in a measured quantity of water, is in the aggregate immense. Malagutti more rationally refers its origin to the solution of the lead-ores, very abundant all over the globe, with which sulphurets of silver and copper are combined. By the action of salt, the sulphurets are converted into chlorides. As to iron, it would be strange if so universal a substance were not found in the sea; and the same may be said of phosphoric acid.

The researches of M. Dieulefait into the presence of lithium in sea-water have shown that the Dead Sea is an independent body of

water, and not an abandoned lagoon of the Red Sea. By chemical and spectral analysis, it contains neither iodine nor silver, nor lithine, while all those substances are found in the Arabian Gulf, a body whose waters differ from those of the oceans only by their greater density consequent on the strong evaporation to which they are subjected.

The determination of the air dissolved in the ocean is attended with many difficulties. We can only indicate a few prominent principles. This air has not the same composition as the air we breathe, although it differs but little in that respect from the air held in springs and rivers. Oxygen, which forms only a fifth of the atmospheric air, being more soluble in water than nitrogen, constitutes about one third of the air which is expelled from water by boiling. The volume of gas absorbable by water diminishes as the temperature rises. Cold water is richer in air than warm. Moreover, the law of decrease being regular for nitrogen, while it is less simple for oxygen, the relative proportions of the two elements are variable in waters of different temperatures. According to Mr. Tornöe, there is a little more oxygen at the surface than theory calls for, while in the zones where animal life is largely developed there is a slight deficiency. The presence of sunlight, or the cutting of it off by clouds, has no important effect; and the same may be said of the enormous pressures to which deep-sea waters are subjected. But little carbonic acid occurs dissolved in a free state, although that gas is very abundant in combination. Mr. Tornöe, who has given this subject careful attention, thinks the older chemists collected carbonic-acid products of the decomposition of carbonates or bicarbonates at the boiling-point He finds an alkaline reaction in sea-water, which he attributes to a small quantity of free salts of soda. Mr. Hamberg, a Swedish chemist, who has recently studied the waters of the Greenland seas, agrees with Mr. Schloesing that marine water contains neutral carbonates, bicarbonates, and slight traces of free carbonic acid, and that temperature and atmospheric pressure have a complex influence on both the uncombined gas and that which is united to bases.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

WHY BIRDS SING.

By Dr. B. PLACZEK.

I HAVE long been an interested observer of bird-life. The situation of my house and garden, on the terrace-slopes of the Spielberg, affords me favorable opportunities for studying the habits of the feathered tribes. They build their nests in my garden, and lend themselves with great docility to the purposes of the friendly spectator of their movements. At one time the nest of a hedge-sparrow (*Sylvia*

curruca) attracted my attention ; I noticed particularly the increased care that was taken by the parent birds, as feeding-time approached, against unwelcome discovery. It was manifested, first, in a cessation of singing, and then in the combined efforts of the pair to divert strange looks from the nest. The birds, when about to take food to their young, were accustomed to fly down from opposite sides, and while one, after many cross-flights through the overhanging foliage, slipped into the nest, the other would flutter wildly hither and thither in another part of the tree. The three half-fledged young birds, when able to glide through the bushes, but not yet to fly, were dislodged from the nest, and while two of them disappeared with the mother, I caught the third, against the anxious remonstrances of the male, and hung it up in a cage in my veranda. The old male stood faithful to his chick, evidently concentrating his whole attention upon it, hopping around among the trees and collecting insects for it from early in the morning till the coming on of night, unceasingly, and never out of the neighborhood. He was accustomed to sound a grating *zapp*, *zapp*, in which the young one soon learned to join, in a variety of tones constituting a whole gamut of modulated sounds, from the note of cheerful pleasure to those of anxiety and anger, and was moved to utterance by the most insignificant event in the cage or around it.

I observed that the male bird, which had sung much less than usual while the female was sitting, and had ceased to sing entirely as soon as the young ones were hatched out, resumed his old habit of song as soon as the fledgeling's domicile was changed from the nest to the cage. He would execute a kind of strophe of from seven to nine clear, ringing notes, having sometimes a joyous and sometimes a melancholy expression. What was the meaning of the song which he thus resumed ? Was it poured out to dispel the sorrow of the lonely orphaned young one? Did the absence of the female give the male a greater liberty in the matter? Or, was it sung in hopes of bringing the female back, or in rivalry with another male ? Pondering over such questions as these led me to reflections and observations on the origin and meaning of the songs of birds.

While we may regard the ordinary vocal utterances of birds as expressions of their moods and wants, signals of intelligence, notes of warning, or calls for help, their song proper must be supposed to describe their more deep-felt emotions and anxieties, and to be related to their common expressions of sound as art is related to the handicrafts that minister to the necessities of life. Like art, the bird-song also, repeatedly exercised, may become an habitual mode of expression.

The majority of ornithologists agree in ascribing an erotic character to the songs of birds ; not only the melting melodies, but also those of their tones that are discordant to the human ear, are regarded as love-notes. Darwin finally, saving some reserves, came to accept

this view. To be able to speak critically of the love-song, one should pay especial regard to the love-life of birds. It would be to throw water into the sea to add to what ornithological writers have advanced concerning the exceeding vital worth and cosmical significance of love. Nevertheless, I venture the opinion that the origin of the song-habit is to be found in other sources as well as in this important factor, among which is the joy of life, manifested in an irresistible determination to announce itself in melody ; and that the song is more perfectly brought out in proportion as this feeling is more highly developed in the organization. Birds in freedom begin to sing long before pairing, and continue it, subject to interruptions, long afterward, though all passion has been extinguished ; and domesticated birds sing through the whole year without regard to breeding-time, though no female or companion ever be in sight. Such birds, born in captivity, never feel the loss of freedom, and, if they are well taken care of, are always hearty and in good spirits. The bird sings, to a large extent, for his own pleasure ; for he frequently lets himself out lustily when he knows he is all alone. In the spring-time of love, when all life is invigorated, and the effort to win a mate by ardent wooing is crowned with the joy of triumph, the song reaches its highest perfection. But the male bird also sings to entertain his mate during the arduous nest-building and hatching, to cheer the young, and, if he be a domesticated bird, to give pleasure to his lord and the providence that takes care of him, and in doing so to please himself. Lastly, the bird sings—by habit, as we call it—because the tendency is innate in the organs of song to exercise themselves.

My male hedge-sparrow, whose truly devoted care of its solitary young one I have described, began, after a ten days' pause, to sing more frequently and intensively, although neither a female nor a male of his species was in the neighborhood, apparently to cheer his ward. His evening farewells, uttered in a clear voice, were peculiarly expressive and touching. When, after eight days more, the chick began of itself to pick food from the dish and to snap at flies, the old bird discontinued its daytime feeding and singing, and came only at night. When the young bird was ready to fly, it came no more.

Female birds, as a rule, do not sing. The mechanism of their vocal apparatus is the same as that of the males, though with a weaker muscularity ; and they are not wanting in ability to give melodious and vigorous expression to the exuberance of their life, but they seem to have lost the habit, or to be without the disposition to do so. Some authors, with Daines Barrington and Darwin, regard their non-inclination to sing as a mark of prudence ; for it would be dangerous for them to make themselves conspicuous during the breeding-season, and direct the attention of enemies to their nests with their precious contents. But some other authors suggest, and I am inclined to agree with them, that they are restrained by a feminine reserve. The knowl-

edge that the ardor of the male can be stimulated by indifference and inflamed to fury by resistance, prompts the female to practice all the arts of coquetry, of which Mantegazza says: "No woman can surpass the wonderful refinement with which a female canary-bird will offer a seeming of opposition to the passion of the male. All the numerous arts with which the world of women can conceal a 'yes' under a 'no' are as nothing compared with the arrant coquetry, the dissembled efforts to escape, the snappings and bitings, and the thousand tricks of the females of animals." Brehm says that the male finds in the female those desirable and attractive qualities that are wanting in himself. He seeks the opposite to himself with the force of a chemical element. A loud singing by the female would be as unpleasant to him as a beard on the face of a woman would be to a man. According to an Eastern proverb, man makes love with his speech, woman by her attitude and bearing. Among the feathered races, whose love-life is more largely and intensively developed than that of any other of the families of animals, the female perceives, feels, and knows that a discreet graciousness, a quiet power, and unobtrusive yet expressive, tender, and gentle manifestations, are attractions that operate irresistibly upon the male, and she therefore adopts them in her demeanor toward her suitor. Toussenel remarks: "Song is also given to the female; and, if she makes no use of the faculty, it is because she knows how to do more and better than to sing. She, as well as her brother, has gone through a course of music in her youth, and has cultivated her taste with the years. This cultivation, in fact, filled a need of both birds, for through it the female has become qualified to appreciate the charm of the elegies that are to be sighed out to her, and to award to the most worthy minstrel the prize for his song. The females know well enough how to express themselves in the language of passion when fancy inspires them to it or solitude condemns them to it." Fischer says that female birds begin at the same time with the males to twitter in the first practice of song, although they never pass beyond the stage of blundering at it. Bechstein remarks that the females of the canary-bird, bull-finch, robin, and lark utter a melodious song, particularly in widowhood. Darwin suggests that in some of these cases of female songsters the habit of singing may be ascribed to the fact that the birds are so well cared for and are captive; for such conditions are most likely to disturb all the functions connected with reproduction. Numerous examples have been mentioned of the partial transmission of secondary characteristics of the male to the female; and it is not, therefore, very surprising to find that the females of a few species also possess a fully developed and active faculty of singing. I will only add to these facts that even for a repressed exercise, and with a restricted muscular activity, a force and a proper organ are requisite, and that therefore the gently modulated, muffled sounds, the peeping, whispering, clucking, smacking, and cooing, with which the females respond

to the persuasions of the male, control their young, and otherwise express themselves, require a vocal apparatus similar to that of the male, which shall not be stunted by non-use. Instead of regarding, as Darwin did, the singing organs of female birds as an instance of the partial but useless transmission of secondary male characteristics to the female, I think we might now plausibly consider it a transmission in undiminished perfection of a faculty generally characteristic of both, but which is most freely exercised in the male on account of its relation to the most important act of his life, and hence to the maintenance of the species.

Singing out of rivalry finds an explanation in the disposition of the exultant songster to show himself off and to surpass others. If this exultant feeling is wanting, as, for instance, when it is depressed by some uncomfortable condition, the emulative singing stops. Hence, freshly-caught birds are songless in the cage, as are also males when several of them are confined together. In these cases the birds are pining for their lost freedom, or are suffering from the feeling of being crowded or hampered in their movements.

Domesticated birds sing also from a kind of gratitude to please their master, after they have discovered that he likes their songs, and the act produces in return a wholesome effect upon them. Under such influences, they sing all through the year, and more than they would do in freedom. I have had the opportunity of making a remarkable observation which shows that singing-birds desire the notice and applause of their attendant, and are affected by them. I had a yellow thrush (*Turdus saxatilis*), taken from the nest, which had become quite tame and confiding. Its cage hung behind the window-curtain of my study, and this adjoined my bedroom. I sometimes heard early in the morning a clear, melodious cock-crowing that seemed to come from a distant barn-yard. I thought of everything to which I might attribute it except my bird, which had never indulged in anything but the simplest song when I was present; but I soon found out his trick. Having risen early one morning and gone into the study while the bird's head was still hidden under his wing, I sat still in a farther corner of the room till matters began to get lively in the cage. Unobserved by my pet, I could see him through the folds of the curtain stretch out his wings and one foot, and plume himself. Then he found his voice and sounded out the cock-crow which I had heard so often from my bedroom without suspecting its real origin. Had I not seen the bird's mouth open and his throat vibrating, I should still have thought the sound came from a distance. Suddenly I stepped behind the curtain, when the bird, perceiving me, broke off at once in the midst of his crowing—a thing he had never done when I appeared as a witness to his ordinary singing—and fluttered timorously around as if he had done something wrong. I went out from the room and waited near, but the bird did not crow any more, nor again for two days afterward.

Then he ventured upon a repetition of his exercise before anything had moved in his neighborhood. I opened the door in the midst of his practice and he stopped, and he never would crow when any one was present. There is nothing particularly remarkable in the crowing of itself, for many birds imitate the sounds made by other animals. The curious fact about this circumstance was, that the bird would not crow in my presence, and would always stop when any one appeared to witness his exercise. There is no evidence that he had ever had an unpleasant experience in connection with crowing. His conduct must therefore be attributed to a kind of feeling of shame, or to a sense of the unfitness of that method of expression to a bird of his character and standing. Have we not in this another proof of the possession by animals of a psychical quality which it has been usual to regard as peculiarly and distinctively human?—*Translated for the Popular Science Monthly from Kosmos.*

SKETCH OF SIR DAVID BREWSTER.

THE contributions of Sir David Brewster to the progress of science were principally connected with his researches in optical properties and phenomena; and many of his discoveries in this line were almost immediately turned to practical use. He also did a wholesome work in diffusing knowledge and awakening interest in scientific subjects by the publication of his popular and readable but accurate and carefully prepared books.

Sir David Brewster was born at Jedburgh, Scotland, December 11, 1781. His father was rector of the grammar-school, and a teacher of considerable reputation, whom neighborhood fame characterized as "the best Latin scholar and the quickest temper in Scotland"; but he was kindly withal. It was intended that David should become a minister, and he was sent to the University of Edinburgh, to be educated with a view to that profession, when only twelve years old. His tastes had, however, even before this time, turned into another direction. It is recorded of his earlier school-days that, though he was never seen to pore over his books like the other boys, he always had his lessons, kept a prominent place in his classes, and was frequently applied to by his fellow-pupils for assistance. And it was in the days of his childhood "that a dilapidated pane of glass in an upper window of his father's house produced the inquiring thoughts which led him afterward to search into the mysteries of refracted light."

He had become acquainted with James Veitch, of Inchbonny, half a mile from Jedburgh, whom Sir Walter Scott has mentioned as a "self-taught philosopher, astronomer, and mathematician." Veitch

was a plow-maker by trade, but was well versed in astronomical calculations and observations, having been the first discoverer of the great comet of 1811, and was in his most congenial pursuit when he was making telescopes, a work to which he brought much mechanical skill and scientific accuracy. His "scientific workshop," on the Jedburgh turnpike, "became a gathering-place for all the young men of intelligence in the neighborhood, most of them being in training for the ministry, for medicine, and other liberal pursuits. They had lessons in mathematics and mechanics, but especially in the favorite science of astronomy. The telescopes were tested in the day-time by the eyes of the birds perching on the topmost branches of the 'King of the Wood,' a noble relic of the past forest days, about half a mile from Inchbonny. When the bright sparkle of the bird's eye was distinctly visible by day, James Veitch's specula and lenses were considered fit to show the glories of the sky by night." David "was the very youngest," says his daughter, Mrs. Gordon, from whose book * we borrow our anecdotes, "of the quaint and varied group. When he began his visits I do not know, but we find that at the age of ten he finished the construction of a telescope at Inchbonny, which had engaged his attention at a very early period, and at which he worked indefatigably, visiting the workshop daily, and often remaining till the dark hours of midnight to see the starry wonders and test the powers of the telescopes they had been making."

Brewster gave faithful attention at the university to the studies which were assigned to him, having no intention as yet, nor for a considerable time afterward, to allow them to be superseded by any other. Yet all the time we find scientific questions prominent in his thoughts, and growing in interest to him. At every holiday he would make the journey to his home, a distance of forty-five miles, on foot, and then, before the day had ended, of another half mile to Inchbonny, to have a scientific chat with his friend Veitch. His letters to Veitch during this period are frequent, and full of references to scientific questions and scientific men. He is making an electrical machine, and tells of all his experiments and difficulties; he has made a map of the stars near our planet, and offers suggestions about grinding speculums; he is greatly satisfied with his telescope, to which, or any of Veitch's instruments, the great Newtonian reflector at the observatory can no more be compared than "a dirty common refractor with a fine achromatic telescope"; and he describes how a galvanic column may be made by combining copper or silver coins and pieces of tin or zinc with disks of card or leather soaked in water. These things were much more novel in those days than they are now. "He had," says his daughter, "a sincere attachment to the principles and constitution of the Established Church of Scotland, and a thorough acceptance of her doctrinal standards," and was duly licensed to preach. His first ser-

* "Home-Life of Sir David Brewster," Edinburgh, 1869.

mon was preached in the West Kirk of Edinburgh, one of the largest churches in Scotland, before an unusually crowded congregation; and he preached frequently for some time afterward. His ministrations "seem always to have been most acceptable from the beauty and earnestness of his style, and his well-known gift of creating interest out of the driest subjects." But he was excessively nervous, and his efforts were attended with intense suffering, in the shape of a nervous faintness, which only occurred when he was making a public appearance. For this reason he finally desisted from preaching.

His regular philosophical studies began in 1799, when, at the suggestion of his friend Brougham, he repeated Newton's experiments in the inflection of light, and in connection with them made his first discovery. His after-life was one of almost uninterrupted research. His investigations were to a large extent parallel with those which Malus and Fresnel and others were carrying on during the same period in France, and in some cases room was left for question as to priority of discovery. But in no case is Brewster's claim to independence in research and originality impaired. Professor Forbes has summarized the most important subjects of Brewster's inquiries at this time, as the laws of polarization by reflection and refraction, and other quantitative laws of phenomena; the discovery of the polarizing structure induced by heat and pressure; the discovery of crystals with two axes of double refraction, and many of the laws of their phenomena, including the connection of optical structure and crystalline forms; the laws of metallic refraction, and experiments on the absorption of light. Of his discoveries, primary importance belongs to those of the connection between the refractive index and the polarizing angle, of biaxial crystals, and of the production of double refraction by irregular heating.

In 1816 he devised the kaleidoscope, which became at once very popular, and spread his name widely among all classes of people. The patent which he took out for it was of little value to him, for the authorized manufacturers seem to have wholly failed to supply the demand for the instruments, and the device was speedily patented by enterprising adventurers who made their fortunes out of it. He afterward made earnest and long-continued efforts to promote reforms in the patent laws that should make them more just to inventors.

Several years later, in 1849–'50, he perfected the stereoscope, the principle of which had been discovered and applied by Wheatstone in 1838. Wheatstone employed mirrors to effect the merging of the binocular pictures into one; Brewster substituted lenses for the mirrors, and gave us the instrument substantially as it is.

For the improvements that were made in lighthouses during the second decade of this century, the credit must be divided between Brewster and the Frenchman Fresnel. Both worked independently, and arrived in some cases at nearly identical results. Sometimes Brewster, sometimes the Frenchman, was ahead on a particular point.

Their works have outlived them, and commercial men and sailors have reason every day to bless the memory of both; and of the Englishman, his successor as Principal of the University of Edinburgh has said with truth, "Every lighthouse that burns round the shores of the British Empire is a shining witness to the usefulness of Brewster's life."

Hardly less important in forwarding the progress of science than his direct labors, was the part which Brewster took in the formation of the British Association for the Advancement of Science. "The decline of science" had been much talked of among scientific men for several years, and much thought had been given to the consideration of means of reviving scientific interest, when Brewster, reviewing in the "Quarterly Review" a work on the subject by Babbage, proposed "an association of our nobility, clergy, gentry, and philosophers," as that which "can alone draw the attention of the sovereign and the nation to this blot upon its fame." In the course of a few succeeding months, the plan of the British Association met with general acceptance, and was soon thoroughly matured; and the first meeting, held at York, in September, 1831, at which three hundred and twenty-five members enrolled their names, and a zeal for science was excited "which will not soon subside," was attended with a success that "infinitely surpassed all our most sanguine expectations." At the twentieth meeting of the Association, held in Edinburgh in 1850, Brewster was the president.

Brewster's literary activity kept pace with his scientific work. It was begun at the same time, in 1799, when he became a regular contributor to the "Edinburgh Magazine," and was continued in various shapes as he had new investigations of his own to describe, the work of others or any marked progress in science to review, or views of his own to publish on the topics which from time to time became prominent in the various regions of thought. In 1807, acting upon a casual hint given him by the Rev. Mr. Ramsay, of Tranent, of how much a good and thorough encyclopædia was needed, he began the "Edinburgh Encyclopædia," which was not completed till 1830. In connection with this work we find him, just after the first two numbers had been published, writing to his friend Veitch for a drawing and description of his new plow, to be inserted in the article "Agriculture," and mentioning an intention also "to publish in the same article a curious paper by Mr. Jefferson, President of the United States, on a plow-ear which offers the least possible resistance." This work was strongest in the scientific department, to which the editor contributed many of the most valuable articles. Like all such works requiring a combination of many minds, it was difficult to manage, and cost Brewster much labor, vexation, and anxiety. He was afterward a contributor to the "Encyclopædia Britannica," to the seventh and eighth editions of which he furnished articles on hydrodynamics, magnetism, microscope, op-

tics, stereoscope, voltaic electricity, etc. In 1819 he assisted in establishing the "Edinburgh Philosophical Journal," afterward the "Edinburgh Journal of Science," which took the place of the "Edinburgh Magazine," and subsequently became its sole editor. He also had a part in founding the "North British Review," and was a regular contributor to it, having been the author of seventy-five articles that appeared in it. In 1838 he was appointed Principal of the United Colleges of St. Salvator and St. Leonard, St. Andrews, and in 1859 became Principal of the University of Edinburgh. His life at St. Andrews was checkered by transient difficulties that grew out of his excessively nervous temperament. At Edinburgh, a minute recorded by the University Court after his death described him as "one whose warm interest in the university never abated to the last, and who, on the many occasions on which he presided over their deliberations, or was associated with them in business, evinced the sagacity of a clear and disciplined intellect and the courtesy of a kind and Christian gentleman, while each member of it feels that by his death he has lost a valued and respected friend."

In 1825 Brewster was made a corresponding member of the French Institute. From this time, says Mrs. Gordon, "honors crowded in so rapidly upon him that, except any of special interest, it would be tedious to enumerate them in their order and succession. Suffice it to say that the large book in which the letters, diplomas, burgess-tickets, announcements of medals, etc., are collected is a remarkable one for size and value. The large towns of Switzerland, France, Germany, Holland, Italy, Russia, Belgium, Portugal, Austria, Sweden and Norway, South Africa, Antigua, the various States of America, besides the towns and universities of England, Scotland, and Ireland, all contributed their quota of honors to this man of research and industry. A cape received his name in the Arctic regions, a river in the Antarctic, and a new plant discovered by Dr. Muellin in Australia was named *Cassia Brewsteri*. He received, besides the Copley, Rumford, and Royal medals, two Keith medals from the Royal Society of Edinburgh, two from the French Institute, one from Denmark, one from the Société Française de Photographie, and various others; of some of the most valuable of these, duplicates were sent to him, one of gold, which he turned into plate, and a fac-simile of frosted silver—all being preserved as heirlooms. He was knighted in 1831, the year of the first meeting of the British Association, and also received the Hanoverian Order of the Guelph."

In examining Mrs. Gordon's most interesting work we have been struck with the variety of subjects in which Sir David Brewster was interested, and of the discussions in which he took part. We can only mention some of them, as we find them laid down in the table of contents. Connected with his researches on light were all matters relating to photography and color-blindness, which was strikingly exemplified

in his friend Dalton, and on which he wrote an article for the "North British Review." In church matters, he made one of the first suggestions that led to the formation of the Evangelical Alliance; he took a prominent part in the disruption of the Church of Scotland, and was one of the founders of the Free Church—at the cost of much tribulation and an unsuccessful suit to eject him from his chair as Principal of St. Andrews; and throughout his life he stoutly upheld the harmony between the results of scientific investigation and his orthodox religious faith. Then we find him a warm believer in the authenticity of Mr. Macpherson's "Poems of Ossian"; an interested spectator of the beginnings of the electric telegraph; putting aside his dislike to prominent positions to act as President of the Peace Congress in 1851; discussing the doctrine of the plurality of worlds; investigating the spirit-rappings; and finally inquiring into every new phenomenon, and busying himself with everything that could contribute to the advancement of knowledge or the benefit of mankind.

The reform of abuses was one of the passions of his life. For three years he lived at Belleville, on the estate of his wife's sister, and had a full field for gratifying it on a property which had been for many years "too indulgently superintended." He "awakened a warm and abiding attachment among the majority of the Highland tenantry, who anticipated with delight the time, which never came, when he might be their landlord in very deed. They were proud of his scientific fame, which indeed spread far and near. I remember four working-men coming a considerable distance from Strathspey, with the petition that they might see the stars through his telescope; while on another occasion a poor man brought his cow a weary long journey over the hills, that the great optician might examine her eyes, and prescribe for her deficiencies of sight; and all, as was ever his wont, were received courteously, and had their questions not only answered, but answered so clearly and patiently that the subjects were made perfectly intelligible and interesting."

"All who knew him," says Miss Forbes, afterward the wife of the Rev. Canon Harford Battersby, "will, I am sure, unite in testifying to his readiness to explain, it might be, the simplest principles of a science to some insignificant person, and the wonderful enjoyment he seemed to find in so doing—quite as much, indeed, as in talking of some of his latest discoveries to the most learned—if only his listener were thoroughly interested and anxious to learn." One person, "himself the possessor of genial gifts and genius," is quoted as having remarked, "When I have been with other great men, I go away saying, 'What clever fellows *they* are!' but when I am with Sir David Brewster, I say, 'What a clever fellow *I* am!'" Miss Horsbrugh, whose tutor he was from 1799 to 1804, gives a pleasant picture of him as a great favorite with the children, especially with those who could enter

into his own pursuits, and fond of experimenting before them, particularly with his electrical machine. She remembers the starts and shocks she received, and also being occasionally left alone in the dark, when Mr. Brewster would appear among them with his outstretched hand and fingers all in an apparent blaze from phosphorus. Some of his scientific practices greatly incensed Mrs. Dickson, the housekeeper, who declared that he would never rest till he had set the house on fire.

His principal literary works, many of which have obtained a wide popular circulation, are his "Life of Sir Isaac Newton," published in Murray's "Family Library," and the larger memoirs embodying the fruits of twenty years of investigation, published in 1855; his notes and introduction to Legendre's "Geometry" (1824); his "Treatise on Optics" (1831); "Letters on Natural Magic" (1831); "The Martyrs of Science" (1841); and "More Worlds than One" (1854). The list of his briefer scientific papers and miscellaneous writings includes, besides the seventy-five articles contributed to the "North British Review," three hundred and fifteen titles.

A monition of the waning of his vital powers came to Sir David in the spring of 1867, when he lost consciousness in a fainting-fit in his class-room at the university. He attended the British Association at Dundee, in September of the same year, and had another fainting-fit, after enduring the crowd and heat of the public assembly. He returned to his home, never to leave it again, but had to occupy himself with the papers of the forged Pascal-Newton correspondence, and to ward off from Newton's memory the blot which it was attempted to put upon it. This was the last act of his scientific and literary career. "He went straight from this controversy into the gathering silences," and died, at Allerly, Melrose, February 10, 1868.

CORRESPONDENCE.

"QUEER FLOWERS."

Messrs. Editors:

In reading the interesting article by Grant Allen on "Queer Flowers," in the December number of this "Monthly," I observe some statements concerning the fig which observation here in California, where the tree is very common and grows luxuriantly, does not confirm. In the first place, the *caprifico* does not, so far as I am aware, grow here at all. We realize, therefore, a condition the same as though it had "become extinct"; and yet the supply of figs—"best Eleme in layers"—has not "ceased entirely." On the contrary, figs here in the city are a drug, and are literally trodden under foot of men on the sidewalks overhung by the trees; and in the country they lie rotting on the ground in thousands upon thousands for lack of the labor and care necessary for their marketing or preservation. This looks as though the "true figs" were not "dependent upon it (the *caprifico*) for pollen," as the writer states; and I am inclined to think that the "extraordinary and complicated cross-relationship" to which, according to Mr. Allen, the flowers of the fig owe their fertilization, is a myth, and, on the strength of the argument *a posteriori* alone, should be relegated to books for the nursery.

But, in addition to this, let us look at the (literally) internal evidence afforded by the fig itself against this mythical cross-relationship. The flowers of the fig, growing as stated on the inside of the hollow stalk or receptacle, which forms when ripe the main bulk of what is popularly known as a fig, are of two kinds, viz., male and female; that is to say, the male, or pollen-bearing organs (stamens), and the female, or seed-bearing organs (pistils), are borne on separate stalks, just as in the melon and cucumber. But while in the last-named plants the different flowers are placed at some distance apart on the vine, here they are crowded together in the hollow receptacle in close contact and in almost every conceivable relative position, above, below, and on all sides; and the hollow receptacle is all but completely closed by an irregular fringe of metamorphosed bracts which surround the eye ("hole," by courtesy) in the distal end. They (the flowers) are, therefore, in the best possible condition for self-fertilization, without any external aid from insects. The fig, in fact, presents in its *synconium* an analogy to the perfect *Cleistogamous flowers* found scattered through several orders and genera, which, although containing both stamens and pistils, do not open out or bloom, yet nevertheless, producing abundance of seeds, prove themselves to be self-fertile.

Note here, however, that I do not assert that the flowers of the fig are generally or in any great number fertile; indeed, I have reasons to doubt this being so, for I have yet to see the first seedling fig-tree. And yet, from the great number of seeds (fruits?) falling on the ground and being covered up every season, it would seem almost certain that, if they were generally fertile, at least a few would germinate; and this brings me to another statement of our talented writer, which will bear examination before acceptance, viz.: ". . . *as the figs won't properly swell without fertilization*, . . . and for this reason the Italian peasants hang on the tree small branches of the *caprifico* . . . at the moment when the eye of the fig opens, and *so shows that they* (*the flowers*) *are ready to be fertilized.* The wasps . . . enter the figs at once and there set the little hard seeds, *on whose fertilization the pulpy part of the fig begins to swell.*" The italics are mine.

Is it certain that the swelling or ripening of the fig is at all dependent on the fertilization of its contained flowers or any of them? The pineapple presents a case in point which negatives the proposition, at least as a general one. Here the flowers are on the outside of a simple axis, in form of a spike. The axis continues growing beyond the spike of flowers, and may be cut off and rooted to form a new plant; in fact, this is the common and, I believe, the only mode of its propagation. Now, the pineapple as a fruit is formed by the axis, together with the surrounding and constituent flowers, bracts, etc., swelling and blending together in ripening into a fleshy, juicy mass, *but the flowers are sterile and seedless.* The plantain and banana likewise both ripen their fruits without the fertilization of their seeds. Although I am not in possession of conclusive evidence on this point, I am disposed to think, from some facts already stated, that the fig (through long continued propagation by layers or cuttings?) is approaching the condition of a seedless plant. Be this as it may, it has, I think, been shown that the "fig-wasp" may be stricken out of the account as surplusage, together with the pollen of the *caprifico*, with the result of no fewer figs and a nearer approach to the true story of the *Ficus carica.*

GEORGE PYBURN.

SACRAMENTO, CALIFORNIA, *December*, 1884.

A NOVEL PHENOMENON.

Messrs. Editors:

While several students of the University of Nebraska were geologizing in an outcrop of the Dakota group, situated in the western portion of Lancaster County, Nebraska, about thirteen miles west of Lincoln, they brought to light a curious freak of Nature. This was a leaf-impression, or rather the fragment of an impression, that preserved the green color which it wore several million years ago at the commencement of the Cretaceous period in geological time.

The deposit in which the leaf was found is a maroon-tinted sandstone, quite soft when first quarried, but solidifying rapidly after exposure to the atmosphere. The total thickness of the layers which outcrop at this point is about forty feet. The true dip is too slight to be accurately measured.

None of the layers of sandstone—and this is the sole kind of rock found in the Dakota group of Lancaster County—are of the peculiar reddish shade except that which contains the leaves. This layer averages nine inches in thickness, and is situated near the upper surface of the group.

The leaf-impressions obtained were many of them very beautiful and complete, representing various species of *Juglans*, *Laurea*, *Liquidambar*, *Salix*, and *Quercus*, with many others. They were very numerous, as many as two thousand specimens being obtained in a few hours.

The unique green leaf-fragment was too small to allow of successfully determining its genus or species. It is probably *Laurea*, however, since it was found in a mass containing impressions of *Laurea* almost exclusively. C. G. McMillan.

1503 H Street, Lincoln, Nebraska, *October* 23, 1884.

EDITOR'S TABLE.

"*MIND AS A SOCIAL FACTOR.*"

This is the title of an article contributed by Mr. Lester F. Ward to the quarterly periodical "Mind." Mr. Ward, as is well known, is the author of "Dynamic Sociology," which contains an elaborate attack, with all the weapons of science and philosophy, upon the doctrine of *laissez faire*, as it is termed, or the policy of meddling less, and leaving things social more to their own natural courses. One of the chief arguments of the book is reproduced in this paper, and, as the subject is important, we propose briefly to examine it, and offer some objections to the view taken.

Mr. Ward argues that the *laissez-faire* school of thinkers fail to recognize the true office of intelligence in controlling social activities and accomplishing social ends. He begins by stating that they make their constant appeal to Nature, to the laws of Nature, and the method of Nature, as all-sufficient for working out social good, so that man's agency in the matter, where not mischievous, is superfluous. He then proceeds to show that this view leaves out of account the most momentous fact in the history of this world, namely, the advent of mind as a controlling agency in terrestrial affairs. He does not deny that there is, or has been, a method of Nature, and that in past times it has accomplished great things. He recognizes that it worked on, by the law of evolution, through vast periods, reaching higher and higher stages, until at length was ushered in the grand era of mind. A new order of things was now initiated. In the matured epoch of mind, advanced human intelligence took control of the planet. Its forces were subjugated and pressed into human service. The old method of Nature, by which progress came through destruction, wastefulness, and cruelty, gave place to a new method, that of art, which is the antithesis of Nature, and of humane protection of the weak instead of their remorseless destruction. The new era of mind was marked by inventions, constructions, and industries, by the rise of institutions of justice and beneficence, of governments, civilizations, and all the regulative agencies of human affairs.

Mr. Ward then takes the ground that those who still talk of following

the method of Nature, and deferring to natural laws, quite overlook the meaning of these supreme facts, and seem unaware of the new dispensation upon which the world has entered. He makes "The open charge that the modern scientific philosophers fail to recognize the true value of the *psychic factor*"; and again he says, "The *laissez-faire* doctrine fails to recognize that, in the development of mind, a virtually *new power* was introduced into the world."

Mr. Ward must not be here taken too literally, for certainly the *laissez-faire* people have some appreciation of mind as a factor in social progress. He can only mean that they have a very imperfect conception of it, because their do-nothing method does not imply the need of it. It is desirable, however, that we have first of all a correct idea of what this policy is. And here we must protest against some of Mr. Ward's extreme assertions. He declares that "the *laissez-faire* doctrine is a gospel of inaction"; and that, to be consistent, "its advocates must condemn all interference with physical laws and natural forces." He says they hold that "all schemes of social reform are unscientific"; that "they condemn all attempts to protect the weak, whether by private or public methods"; and that "in government every attempt to improve the condition of the state is condemned and denounced." These are unwarrantable exaggerations. The representatives of *laissez faire* have as much at heart the good of society, and work as hard to secure it, as any other class. It is not true that they hold to the method of Nature in social life in any such sense as absolves men from active effort in the direction of social improvement. Mr. Herbert Spencer is probably, as Mr. Ward himself recognizes, the leading living representative of the *laissez-faire* school, and he repeatedly, explicitly, and consistently in his earlier as in his later works, enforces the obligation of protecting the weak by sympathetic and discriminating aid, and he ever maintains that there is no more commendable or admirable social service than to help the weak and poor to help themselves. Moreover, his works throughout, from first to last, make imperative demands for radical and comprehensive scientific reforms in the policy of government with respect to the administration of social affairs. This is the common and distinctive ground of the *laissez-faire* school; and the question here is simply, What value does this give to "mind as a social factor"?

The believers in *laissez faire*, or in leaving things social more to themselves, hold that there is a natural order in the social state which has not been superseded or antiquated by the coming of man upon the stage, and that there are natural laws of human society, the understanding of which is the first condition of all real social advancement. They maintain that blind and ignorant intermeddling with these laws has been and is still productive of far more evil than good, and that therefore the first grand task of social science is their full and systematic elucidation, while it becomes the highest duty of education to disseminate knowledge of the laws thus gained. But the disentangling of social phenomena and the clear working out of their underlying principles are certainly among the highest efforts of the human mind. As yet we have only partial glimpses of these laws, insufficient for full guidance—but little more than sufficient to attest their existence. The most profound and fruitful intellectual work for generations to come is to be done here. Can it be said that those who contribute to the solution of these formidable social problems—so fundamental to practical success in social undertakings—are open to the charge of disparaging the function of "mind as a social factor"? On the contrary, is it not they who most eminently honor it? Mr. Ward not only admits that there are social laws which

it is perilous not to know, but he recognizes that this is the essential fact of the *laissez-faire* view. He says: "What, then, remains of the *laissez-faire* doctrine? Nothing but this: that it is useless, and may be dangerous, to control natural forces until their character is at first well understood." "Nothing but this"! And is the thorough understanding of social forces in their complicated actions and reactions really so trivial a thing? We have been wont to consider sociology — the true social science inductively based and deductively verified as dependent for its establishment upon all other sciences—as the most intricate and difficult of all, as but just fairly reached in the progress of the human intellect, and as requiring the highest range of intelligence for its successful investigation; and, if so, then by insisting that the recognition and understanding of social laws is an indispensable prerequisite to safe and effective social action, the believers in *laissez faire* put the highest premium upon intelligence, both as an instrument of the establishment of truth and a means of general education.

Again, and in another aspect, *laissez faire* implies, and by its nature provides for the best mental development. Its advocates insist that, in dealing with social subjects, there should be more reliance upon individual action, more personal responsibility, more spontaneous co-operation, and larger demands upon private enterprise. But this view obviously makes intelligence the controlling factor in social life, for successful self-direction is only possible with increasing knowledge, keener discrimination, and greater mental activity on the part of the actors. Not only is the highest pressure thus put upon individuals, but the conditions are favorable for what is most needed — self-improvement. There is no such thing as corporate intelligence, it is ever an individual thing. Whatever view we take of the nature of mind, it is essentially a personal attribute. If we hold it to be a special divine gift, it is still a gift to the individual primarily for individual uses. If we hold that mind has been naturally evolved, its development has come through individual experiences as a preparation for the care of individual interests. On any view mind is a personal endowment, its aptitudes a personal inheritance, its unfolding a result of personal exertion, and its exercise a matter of personal responsibility. The system, therefore, which calls for greater self-reliance and more independent self-direction, must not only assign a prerogative value to the social function of mind, but it adopts the only possible means of attaining its highest advantages. If it be said that the idea of sufficient general intelligence for social guidance is a chimera, that only shows that the *laissez-faire* view overestimates what mind can be made to do.

Can it be for a moment maintained that the opposite school, which favors corporate and wholesale social regulation, the tendency of which is to paralyze the incentives to personal effort, places a higher estimate upon "mind as a social factor" than that which insists that citizens should rely more upon themselves and not shirk their individual duties? And what less is this higher trust in state compulsion as against voluntary action than a virtual abdication of the function of intelligence in the control of social activities? Working by deputy is assuredly not the best way of securing intelligent action. Is it too much to say that the system of coercive regulation flourishes best in ignorance? Ignorant constituencies clamor for endless legislative intermeddling, and equally ignorant representatives give them what they want. Notwithstanding all Mr. Ward says about the ascendency of *laissez-faire* ideas, do they control the public policy, or are they not limited to a few teachers who are generally disparaged as mere speculative *doctrinaires?* Are the members

of Congress and of the State Legislatures and their accompanying lobbyists, who devote themselves to the regulation of social affairs, well-instructed men who have availed themselves of what there is of social science, or are they not as a class distinguished by their ignorance and contempt of the subject? Not much knowledge is required to make laws; much to make them wisely and intelligently. Laws of every sort for the control of society are blindly enacted, amended, repealed, or left to become dead letters, while only so much of legislation gets executed as happens to conform to the actual state of general intelligence. Such hap-hazard, ill-adapted action does not give a very exalted idea of "mind as a social factor."

THE RELATION OF SCIENCE TO CULTURE.

Culture may, we think, be properly described as that knowledge or training which is essential to, at least, a provisional completeness of human nature. To secure such provisional completeness all the lines of a normal human activity must be more or less occupied, all the permanent faculties and capacities of the normal human intellect must have a certain exercise and development, and so be made channels of happiness and of usefulness to the individual. Viewing the matter in this light, we see that while this or that special piece of knowledge may not be necessary to culture, each *branch* of knowledge and of thought must bring some contribution to it. Culture implies understanding, appreciation, and some power of action. To have a mind wholly unexercised in some important region or regions of knowledge, and therefore wholly incapable of appreciating what may thence be drawn for the general nourishment of thought and advancement of civilization, is to have a culture so far incomplete; and an incomplete culture is, according to our present definition, the negation of culture. It may be that in the case of no human being is our idea of culture fully realized; still, for all that, the idea may be a good one. Manifestly, the aim of culture is to give such perfection to human nature as it is capable of—to develop not one set of faculties only, but all faculties; and so far it is correct to speak of (realized) culture as "a provisional completeness of human nature."

It may, perhaps, be objected by some that the definition of culture here given is calculated to lend aid and comfort to that spirit of dilettanteism which has proved itself so serious an impediment in the past to the progress of true knowledge. Under the pretext, it will be said, of aiming at some kind of completeness of intellectual outfit, many will be found contenting themselves with mere surface knowledge, and shirking all the hard work inseparable from a proper grounding in any one branch of study. To this we can only reply that the requirements of our definition would not really be met by such a course as this, and that nothing would be easier than to expose the charlatan who, not only knew nothing well, but had no proper measure of his own ignorance. A large part of culture, as we here understand it, consists in having some due appreciation of the extent and importance of those fields of knowledge which we have not been able to make our own. We recognize the man of culture not less by his diffidence in regard to those things he has not mastered, and upon which he does not venture even to have an opinion, than by the confidence and precision with which he moves in subjects that he has more or less made his own. Show us the man who, on the strength of a little general reading, will express opinions right and left, or who argues deductively, with reckless confidence, from a few general principles settled in his own mind, and we shall show you one who has never risen to the conception of culture which we are here en-

deavoring to set forth. "The fear of the Lord," says an admirable proverb, "is the beginning of wisdom"; and the first lesson in culture is the correction of that error to which, as Bacon has pointed out, all untutored minds are prone, of supposing in nature a greater simplicity than really exists.

Now, the contribution which science brings to culture is this:

1. It imparts actual knowledge of the condition and constitution of the external world.

2. It trains the observing and reasoning faculties.

3. It imparts a knowledge of its own methods, and by so doing gives the mind a new consciousness of its powers; for the methods of science are simply the labor-saving methods of the mind itself.

We see, therefore, its relation to culture. That wholeness of the mind of which we have spoken is manifestly incompatible with gross ignorance and error in regard to the source whence all sense-impressions flow. It is not culture to be floundering amid hopelessly erroneous hypotheses, nor to see things only with the untrained eye of sense instead of with the inward eye of instructed reason. Culture—intellectual wholeness—requires that we should see the world as those see it who have studied its phenomena and laws; not that we should know all that each specialist knows—a manifest impossibility—but that we should in a general way know what report has been brought from each great field of inquiry. So in the days of Columbus· culture did not require that each man should visit the new continent for himself; but culture did require that each should know that a new continent had been discovered, and what its general features were, so far as it had been explored. The man of culture to-day should be able to speak of the world as it is now known to be, not as it was supposed to be fifty, or a hundred, or two hundred years ago.

Secondly, science trains the observing and reasoning faculties. The habit of direct observation of Nature is one of the most important that any human being can acquire. By bringing the observer into direct contact with Nature, it gives a healthy concreteness to his conceptions. He who misses this training in early life will not be likely to make good the deficiency in later years. Many men, who have naturally good reasoning powers, find themselves condemned to more or less of intellectual sterility, simply because what we may call the fact-grasping faculty has never been developed in them. If they had materials to work with, they could do good work; but they have not the materials, and do not seem to know how to gather them. They live in a too attenuated air: like the ancestral ghosts whom Myrtle Hazard saw in her dream, they call for "breath! breath!"—the breath that no living soul need lack who will but go to Nature for a supply. It may be said, indeed, that a logical faculty without a strong sense for the concrete is a source of danger to its possessor, leading him afar on the seas of speculation, with no guide but a few charts and his own dead-reckoning. He who can observe Nature, on the other hand, is like the mariner who can "take the sun," and know his exact position from day to day. Many of the intellectual evils of the present time spring from the too wide-spread use of intellectual faculties untrained by the study of Nature, and therefore unchecked by any due sense of the complexities which the problems of life present. Science teaches caution; it teaches the paramount importance of verification, and creates not only a distrust of, but a certain lack of interest in, conclusions that have not been reached by proper methods, and which do not admit of verification. Scientific men, in general, it will be observed, are not revolutionary in their opinions; they work on patiently, and hate nothing so

much as premature production of results. They often have occasion to smile at the confidence with which mere theorizers undertake to tell the world what the whole significance of their work is.

The methods of science are, as we have said, the labor-saving devices of the human mind. They are the choicest and most precious results of the travail of the human intellect upon the phenomena of its environment. Not to know something of them is, in a wide sense, one of the worst forms of self-ignorance, for the intellect that has worked out and established these methods is not any individual intellect, but the intellect of the race. We are all entitled to our share in what the race has accomplished. And shall we supinely and ingloriously consent to be ignorant of the intellectual triumphs that the race has won? The man of culture must have a consciousness of his own best self, and must have it in his power to live his best habitually, and not be dependent upon critical occasions to reveal what his capacities are. The function of culture is to redeem us from the sway of chance, and make us fully masters of ourselves. We see, then, what it must be, from the point of view of culture, to know the ways of Science, and to be able to trace her shining footsteps along some of the grander paths of discovery. We see, too, what, from the same point of view, it must be not to know anything of all this, but to live in a world the phenomena of which never reflect back the light of law into the understanding, or convey any clear suggestion of the conquests which the human mind has achieved. To think that, not so long ago, this condition of mind was thought by many, yes, by most, quite compatible with "culture"! Times are changing, fortunately, and we trust that few men of intelligence are now to be found who would dispute our definition of culture as a certain provisional completeness of the human mind in the sum and development of its faculties, or who would deny that, to constitute such completeness, a liberal scientific training is wholly indispensable. Each of the points on which we have touched would admit, as every one can see, of much expansion; but we thought it well to present the general argument for once in this very summary form, reserving the liberty of returning to the subject and treating it in more detail as occasion may serve.

LITERARY NOTICES.

Principles of Political Economy. By John Stuart Mill. Abridged, with Critical, Bibliographical, and Explanatory Notes, and a Sketch of the History of Political Economy, by J. Laurence Laughlin, Ph. D., Assistant Professor of Political Economy in Harvard University. A Text-Book for Colleges. New York: D. Appleton & Co. Pp. 658. Price, $3.50.

Probably the ablest systematic work produced by the modern English school of political economy is the comprehensive treatise of John Stuart Mill. It has been a good deal used in the colleges, but is in several respects imperfect as a text-book. Its two volumes are inconvenient, and the treatment unsuited for class-room purposes. Besides, it was published more than thirty years ago, and the progress of the science within that time has been such that certain parts of Mill's work will bear considerable abridgment, while other parts require modification and further development. Professor Laughlin, of Harvard University, has accordingly undertaken the task of revising the work, reducing it to a single volume and making various additions to it, which give greater prominence to important questions of the present time. The author also exercised his discretion in introducing such illustrations as shall better fit it for the use of American students, and he has also enriched it with a bibliography that will give it a special value for educational purposes. As this edition of Mill's "Political Economy" is now beyond doubt the best college text-book upon the subject, it is desirable that we should indi-

cate with some fullness of detail the nature of the modifications and additions that have been made.

On the "Wages Question," Mill's statement of the "Wages-Fund Theory" is supplemented by the results of the thinking started by Longe, Thornton, Walker, and Cairnes. The conclusion is still retained that the relation between numbers and that part of capital which is necessarily devoted to wages (although not absolutely fixed in amount) determines the average rate of wages, supposing that there is free competition among laborers. Then the adaptation of this theory to the facts of practical life, in which free competition does not exist between distinct occupations, is arrived at by introducing Mr. Cairnes's doctrine of non-competing groups in the discussion of the varying rates of wages in different employments. These additions are inserted so as to naturally supplement and closely connect with Mr. Mill's system, thus introducing the results of study in the generation since Mill wrote his two volumes. These parts are necessarily brief and condensed, but the reader is given references in foot-notes to the writers themselves, which he can consult as he goes on.

Mr. Mill included wages of superintendence under profits, and thereby gave some excuse for much of the wrong talk about a conflict of labor and capital. In this edition it is made apparent by Mill's own showing that wages of superintendence should be classed with other wages of labor, and so the high returns of managers are explained as arising from the same causes which influence the wages of other skilled laborers—the possession of a natural monopoly. This is only an extension of the doctrine of non-competing groups; and profit is then confined properly to interest for abstinence and insurance for risk.

Since Mr. Mill's day the modern form of socialism, whose essential doctrine is state help, has spread from France to Germany through the teachings of Marx and Lasalle, and pervaded our own country. A statement of their position is incorporated into the book, and Mr. Mill's later views on socialism, as expressed in his posthumous chapters (written in 1869), are printed in connection with his earlier views.

The chief weakness of Mr. Mill's book was undoubtedly his treatment of cost of production. The admirable study of Mr. Cairnes has cleared this ground, and the results of that work are given in this edition, so that the reader can get the right conception of this fundamental matter in connection with the remainder of the economic system. This in its turn then makes international trade, as expounded by Mr. Mill, more simple and more easily understood.

The whole lively discussion on bimetalism arose since Mill's day, although he touches somewhat on the double standard. His omission is filled by a considerable study on the experience of the United States since 1792. The history of that experience with gold and silver and the working of our legislation on this subject are stated and explained; and in the Appendix a bibliography of two pages for the subject in general is given.

Mr. Mill's book, of course, contained nothing treating of our own experiments in paper money, but much on English currency discussions. These latter have been omitted; and the experience of the province of Massachusetts, the issues of Continental currency, and the greenback issues from 1862 to resumption of specie payments in 1879, are considered with a view to the lessons that may be learned from this kind of currency.

International values presented unnecessary difficulties to the reader in the form it assumed under Mr. Mill's pen. This was largely omitted, and a very much simpler exposition given of the laws of reciprocal demand and supply, as a supplement to the previous exposition of value.

The connection of wages with prices and the doctrine of comparative cost as affecting foreign competition are added at some length in the chapter on foreign competition. The connection of wages with foreign competition had not risen in Mill's day to its present factitious importance in the vulgar mind.

Mr. Mill's (or rather Mrs. Mill's) chapter on the future of the laboring-classes was rambling and quite obsolete. An entirely new chapter was put in its place, pointing out the very considerable gain of the laboring-classes in wages during the last fifty years in England and America as disclosed

by the statistics. Then the devices of co-operation for giving the laborers a share in the profits of capital and the wages of superintendence, either in the form of distributive or productive co-operation, industrial partnerships, and people's banks, are described, and also the effect of peasant proprietorships on small owners of land in giving them a share of the "unearned increment."

Mr. Mill's chapter on protection was almost out of date; moreover, his own views on protection to infant industries had been more fully expressed in a letter which was inserted by the editor. The arguments concerning wages and the tariff, diversity of industries, and the effect of a tariff on prices, have been added at this place.

The illustrations have been modified so as to apply directly to the United States, as in case of the exchanges, international trade, etc. A marked feature of this edition is the striking use made of illustrative diagrams. The twenty-four maps or charts which bear especially on American conditions have been inserted in order the better to apply principles to the state of things directly about us. This method is of great importance. As many kinds of graphic representation as possible have been introduced. No other text-book on political economy exists which makes use of charts in this way. It both interests the pupil and makes statistics alive, and it stimulates a reader to a study of facts and to the verification of economic principles. The single chart No V is in itself an exposure of the folly of supposing that our railways are grasping monopolies; and chart No. X tells the whole story of the fluctuating value of silver at a glance. As a device in teaching, many small diagrams are used here and there, to show the abstract in the form of the concrete. For example, three concentric circles illustrate the relation between wealth, capital, and money. A good teacher will make others of his own.

Perhaps the most pressing practical difficulty to honest inquirers is a knowledge of books in this age of much publishing. An evident effort has been made throughout the whole work to meet this want by bibliographies. The editor seems to have been animated with an earnest purpose to unlock the results of study upon this subject to every reader, and to give him the knowledge of books which only a very laborious student in a large library could acquire. This was done first by supplying to the new edition the story of the growth of economic ideas and the existing body of laws, attended by the title and date of the books of each writer who figures in this story, so that not only past but living writers are classed in schools and their books given in that connection. Thus, any reader is able to select his additional reading with a clear idea of its tendency and position in regard to other systems. Then a brief list of the most important books in political economy, which would form a small but well-selected library for any teacher or student, has been given under the head of "Books for Consultation" (pp. 43–46). This list will be useful also while the reader is mastering his Mill.

But, after he has finished Mill's volume, bibliographies on various questions of the day are given, in order to furnish readers with the tools for further and special study. For example, in Book IV, Chapter V, p. 6, a list of books treating of industrial partnership is given; and, in Appendix I, bibliographies on our tariff history, bimetalism, and American shipping are given in more detail. Moreover, throughout the work the reader is put in the way of finding publications devoted to other or opposing views from those given in the text. This, it is believed, is a feature not found in any other text-book, and teaches men to compare views for the sake of truth—in short, to think, and not merely to absorb an authority.

In Appendix II, examination-questions will aid both student and teacher in estimating the extent of knowledge necessary to good work. These have been taken from Harvard papers or those set in English universities.

It will thus be seen that this new edition of Mill's work is a contribution to more thorough methods of teaching political economy, and aims at a breadth and liberality of treatment which are now imperatively demanded in the pursuit of this comprehensive and important science. The purpose of the book is to insure a mastery of the subject. The reader who follows all the references

given as he goes along will find several years of work in them; but, while gaining first a general knowledge of the system, he can then easily know where to go for more detailed study on special subjects. To an intelligent reader the work will then be both a manual and a guide.

A System of Psychology. By Daniel Greenleaf Thompson. In two volumes. Vol. I, 613 pages; Vol. II, 589 pages. London: Longmans, Green & Co. Price, 30s.

The unobtrusive issue of this comprehensive work by an American writer will be a surprise to many. We confess to having been somewhat stunned at receiving and looking it over, and not more by its formidable proportions than by the evidences of scholarship, and mastery of the subject displayed in every page we examined. It is undoubtedly the most important contribution to psychological science that any American has yet produced; nor is there any foreign work, with which we are acquainted, that contains so exhaustive, so instructive, and well-presented a digest of the subject as this.

The work is written mainly from the point of view of an expositor. It is the object of the author to put his readers in possession of the present state of knowledge on a broad range of psychological subjects; but, while he makes no claims to any considerable discoveries, his pages betray many intimations of independent and original thought. The work is written throughout in the true spirit of science, which aims only at the establishment of truth, and in its philosophy it of course represents the latest school of psychological doctrine as it has been developed by English thinkers. In a brief preliminary note the author thus explains his relation to the minds that have mainly influenced his course of study. He says: "Besides the little I myself may have contributed, the reader is indebted for whatever science there is in this book chiefly to four other minds: to Julius H. Seelye, the personal teacher of my youth, who showed me that philosophy is possible and necessary for human welfare, and who inspired me with zeal for philosophizing; to John Stuart Mill, the ever-influencing though unseen friend of boyhood, youth, and manhood, who with the first named taught me to love truth above all things else; to Herbert Spencer and Alexander Bain, who with the second of the four have shown me the paths of true knowledge in the department of psychology."

As may be inferred from this statement, and as amply justified by an examination of it, Mr. Thompson's treatise is a systematic and symmetrical presentation of the most modern and authoritative system of psychology in which the views of Mill, Spencer, and Bain are reproduced in a connected and unified form so as to be more available for general students than in the elaborated works of those eminent authors. The task was a formidable one, but it has been thoroughly and successfully executed. The author is not a recluse professor who has been shut up in his library to spin a speculative system of his own, but he is a working lawyer, and a practical man capable of making a valuable and useful book for the public. We have been struck by the thoroughly popular nature of the exposition. The author has evidently been well trained in the important art of plain, direct, and effective statement. He is neither burdened with his learning nor the victim of its technicalities, but expresses himself with the ease and freedom of one who is master alike of his theme and the resources of skillful explanatory presentation. These characteristics adapt the treatise to popular wants, and will give it especial claims upon that large class of American readers who have neither time nor taste to conquer the formidable books on philosophy and psychology, the contents of which are here reduced to more available and attractive form.

The work, however, is large, and the field it covers is so extensive that it will be quite impossible to attempt here any representation of its general plan, any intimation of its distinctive doctrines, or any summary of the numerous problems it deals with.

But while the work is an honor to American scholarship, and the intrepid enterprise of an individual American thinker, we regret to say that it does no honor to American publishing. There is a London imprint upon its title-page, from which we may fairly infer that American publishers decline to undertake the work. Our pub-

lishing enterprise seems not to be up to the requirements of home authorship. And then the meanness of the American commercial system comes in to aggravate the difficulty. If a writer produces a work of great value for American circulation, he is driven abroad to have it printed, and then our enlightened Government forbids its entrance into the country until every copy has paid a tax, which heightens the cost and virtually embargoes its circulation.

The dedication of Mr. Thompson's book is especially interesting as a happy tribute to one of the greatest scientific minds which this country has ever produced. It reads as follows: "These volumes are inscribed by a kinsman of a later generation to the illustrious memory of Sir Benjamin Thompson, Count Rumford, a philosopher, statesman, and benefactor of mankind, a great prophet, who, while living, was not without honor save in his own country, and upon whom dead that praise justly due to a merit almost unrivaled among American men of science has been but tardily and incompletely bestowed, both by his own family and his countrymen at large."

The Reality of Religion. By Henry J. Van Dyke, Jr., D.D. New York: Charles Scribner's Sons. Pp. 146. Price, $1.

The contents of this book are neither so broad as its title, nor are they of the character which would be indicated by it. Religion is a very comprehensive term, of which all systems of religion must be regarded as but partial modifications. "The Reality of Religion," therefore, should involve an inquiry into the element of validity or truthfulness that is common to all religions. But Dr. Van Dyke enters into no such investigation. His book is an ardent pietistic defense of the importance of Christian theology. As a series of vivid and fervid appeals to poor sinners to awake and flee from the wrath to come, it will be appreciated by many, but it will not give much help to those who are grappling with the urgent religious problems of the times. When Dr. Van Dyke says of the dogmas of theology, "They are certainly as important as the dogmas of science," we hesitate, and should be better satisfied if he had indicated in what sense "important"; but, when he says of questions of ritual, "They are at least of equal consequence with the questions of social order," we have no hesitation in saying that he is entirely mistaken.

Thomas Carlyle: A History of his Life in London, 1834–1881. By James A. Froude, M. A. Two volumes in one. New York: Charles Scribner's Sons. Pp. 392 and 417. Price, $1.50.

Mr. Froude's method of portraying the Carlyles has become widely known from his previous volumes. To quote from the present work, "In representing Carlyle's thoughts on men and things, I have confined myself as much as possible to his own words in his journals and letters." These characteristic impressions of John Mill, Landor, Dickens, Tennyson, and other celebrated writers and their works, abound in the letters herein presented. The story of the first three years is a record of discouragement and pecuniary anxiety. Better times began with Carlyle's appearance on the lecture platform in 1837. An interesting item for a history of Yankee "book-pirates" is that, within the next two years, Carlyle received a hundred and fifty pounds from the United States as royalty on his "French Revolution," when "not a penny had been realized in England" by the author, although the receipts of the booksellers had been over a thousand pounds. Carlyle often bewailed his own choice of occupation, and his advice, when consulted by young men, was of the following tenor: "Literature, as a profession, is what I would counsel no faithful man to be concerned with, except when absolutely forced into it, under penalty, as it were, of death. The pursuit of culture, too, is in the highest degree recommendable to every human soul, and may be successfully achieved in almost any honest employment that has wages paid for it." Mr. Froude says of his first meeting with Carlyle, when the latter was fifty-four years old: "I did not admire him the less because he treated me—I can not say unkindly, but shortly and sternly. I saw then what I saw ever after—that no one need look for conventional politeness from Carlyle—he would hear the exact truth from him, and nothing else." An occasional letter by Mrs. Carlyle appears in this work; especially interesting is her written report on the domestic finances, headed "Budget of a *Femme In-*

comprise." In commenting upon the incident of the budget, the biographer says, "Both he and she were noble and generous, but his was the soft heart, and hers the stern one." The letters and extracts from Carlyle's journal concern his literary work, health, visitors, journeys to Scotland and also on the Continent, his religious belief, public policy, etc., etc. His letters to his wife are warmly affectionate, and the entry in his journal relating to her death is wonderfully tender. The criticisms on the "First Forty Years," and the "Letters and Memorials" were apparently the occasion of the introduction to this work, giving Mr. Froude's view of his duty as Carlyle's chosen biographer, with a detailed account of the manner in which the material was put in his possession, and the directions given him in regard to its publication.

WOMEN, PLUMBERS, AND DOCTORS; OR, HOUSEHOLD SANITATION. By MRS. H. M. PLUNKETT. New York: D. Appleton & Co. Pp. 248. Price, $1.25.

THE author of this book is one of those who believe that woman's sphere should be extended; but the extension which she herein advocates is in the line of the usual duties performed by the mistress of the home. She sees no knowledge more befitting woman, no activity more worthy of her abilities, than that which serves to protect the family from disease and untimely death. After a few pages on sanitation in general, Mrs. Plunkett describes the dangers which lurk in wet house-sites and inadequate foundations, and then proceeds with the arrangement of the house for securing sufficient warmth, ventilation, and sunshine. The next chapter deals with lighting, and contains many facts in relation to dangerous burning-oils that every housewife should thoroughly know. Various ways in which water may become unwholesome are told, with directions for tests and measures of protection. The requirements of a good system of plumbing are stated, examples of defective work are given, and some explanation of the nature of sewer-gas and disease-germs is added. As many eminent physicians have declared that cholera will certainly come to America in 1885, a memorandum of the New York State Board of Health relating to the prevention of the disease has been introduced, together with directions for home treatment, including recipes for medicines. These directions are quoted from Rev. Dr. Cyrus Hamlin, who has treated hundreds of cases in the four epidemics which he has seen in Constantinople. The necessity of enforcing public sanitation is urged, both on charitable grounds and because our neighbor's carelessness may often make our own precautions unavailing. The volume contains fifty cuts, showing unsanitary conditions in Washington and New York houses, and elsewhere; elaborate plumbing in the houses of S. J. Tilden and W. K. Vanderbilt; the filtration of water through earth, sewage fungi, etc. The writer has kept house both in the country and the city, and writes with knowledge of the conditions in both locations. The command of the subject which she has gained is a sufficient contradiction of any notion that preventive medicine is too difficult for woman's comprehension. The book, though aiming especially to interest women, is addressed to all readers who desire a popular and practical presentation of this important subject; quotations from the writings of able physicians and sanitarians have been freely used, and evidently care has been taken to make a useful and reliable book.

THE AMERICAN PSYCHOLOGICAL JOURNAL. Quarterly. Volume I. Edited by JOSEPH PARRISH, M. D. Philadelphia: P. Blakiston, Son & Co. $2 a year.

THIS magazine is issued by the National Association for the Protection of the Insane and Prevention of Insanity, and its scope is indicated by the name of the association. The first volume contained articles on both the medical and legal aspects of insanity; W. W. Godding, M. D., contributed a series of papers entitled "Our Insane Neighbor: his Rights and Ours"; T. D. Crothers, M. D., discussed some phases of insanity as related to inebriety; and many letters were published describing the treatment employed in various asylums, the lunacy laws of several States, and the courses of study on mental diseases provided in prominent medical colleges. A few of the other articles are "The Rights of the Insane, and their Enforcement"; "Are Suicides Lunatics?" "Employment as a Remedy for Insanity"; and "The Prevention of Insanity."

Tenants of an Old Farm. By Henry C. McCook, D. D. Illustrated from Nature. New York: Fords, Howard & Hulbert. Pp. 456. Price, $2.50.

At the solicitation of friends, the author has adopted a narrative form for these sketches of insect-life, and has introduced two characters, an uneducated woman servant and an old colored man, who are well versed in the superstitions concerning insects which are current among the ignorant. The book contains many original observations, especially upon the author's specialties, ants and spiders, and aims throughout to express the latest and best results of scientific research. The one hundred and forty illustrations have been prepared expressly for the work, and many of them are comical adaptations by Mr. Dan Beard. Mechanically, the volume is a handsome one, but contains a few typographical errors.

The Way Out. Suggestions for Social Reform. By Charles J. Bellamy, author of "The Breton Mills." A Novel. New York: G. P. Putnam's Sons. Pp. 191.

Having written his novel, Mr. Bellamy proceeds to the trivial task of solving all the problems of modern social life, by promulgating a grand policy of reform which shall prove to be "The Way Out" for all people who find themselves hemmed in by limitations of any sort, and especially the limitations of poverty. His case may be thus summed up: "This is a government by the people who are essentially omnipotent, and can do what they like. The instrument for cutting their way out of all their terrible poverty and misery is the ballot. There are immense accumulations of property, and what is wanted is redistribution. The greatest happiness would be secured by dividing up. The politicians who have got the most ballots are the parties to do this. What is needed is greatly to enlarge the sphere of government in the way of collecting and scattering money. There are abundant precedents for this, as may be readily shown." The author says:

> Government, both national and State, by innumerable acts of legislation, has established precedents, if we seek for justification of our theory, or to speak, I think, more correctly, prove that our theory of the functions of republican government has already been practically accepted, although not carried to its logical sequence. Government already interferes to repair the banks of navigable rivers, to improve harbors, to subsidize steamships and railroads, with a view to the ultimate good they may do the nation. The same national Government fits out expeditions of exploration, and makes costly experiments in agriculture and science for the benefit of the people. The State governments have gone much further. They have loaned money to railroads and canals expected to redound to the benefit of the people, provided large sums for education rendered compulsory, and for the care of the poor, and filled in marsh-lands. County, city, and town governments have carried the theory even further. These last-mentioned governments make free bridges and highways which they care for, establish free libraries and reading-rooms, spend the public money each successive year in some new way, even to appropriating the same for the observance of memorial days, or the celebration of Fourth of July. It certainly seems as if the principle must be acknowledged, after such numerous and varied illustrations, that it is the province of government to make a constant care of the material interests and development of the country, as well as the education and happiness of the people.

In the carrying out of this grand programme the politicians who have got the most votes should regulate all profits, cut down the hours of labor, and, incidentally, take possession of all the land, because, "for the greatest good of the greatest number," "there should be no individual property in land." Then will be found "The Way Out" of "society as now organized" into "the era of plenty."

Like the author's former novel, "The Way Out" is a work of the imagination: the author seems to be concerned about no other laws of the social state than those made by the politicians; and as for political economists they are merely "apologists for an iniquitous society."

The Philosophy of a Future State: A Brief Demonstration of the Untenability of Current Speculations. By C. Davis English. Philadelphia: Edward Stern & Co. Pp. 16. Price, 10 cents.

It has been long agreed that science can not demonstrate the doctrine of a future life or the immortality of the soul; but the writer of this pamphlet seems to be of the opinion that the untenability of current beliefs and speculations upon the subject can be demonstrated. Holding, furthermore, that truth is important, and that truth upon this subject is supremely important, he prints

his views, which have, at least, the rare merit of being very brief. So wide is the range of this discussion, and so many big books have been written upon it, and so diverse are the theories maintained about it, that it was certainly no small exploit to put "The Philosophy of a Future State" in sixteen pages of large and readable type, but our author does not pretend to exhaust the subject. The argument is predominantly psychological, and, if not altogether original, is, at any rate, ingenious.

Elementary Text-Book on Physics. By Professor William A. Anthony and Professor Cyrus F. Brackett. New York: John Wiley & Sons. Pp. 246. Price, $1.50.

In the Introduction, the place of physics among the natural sciences is defined, its methods are stated, and the operation of measuring together with certain measuring instruments, are described. The section on mechanics includes, under "Mechanics of Fluids," the subject called hydraulics in the old books. Heat is treated chiefly in relation to mechanics. A second volume is to follow, treating of electricity and magnetism, acoustics and optics. By this arrangement the connection between light and sound, as being results of vibratory motions, is more emphasized than the connection between light and heat, and the laws of radiation are not presented in the chapters on heat. The book has been prepared for college classes, and is one which students can work hard over. It attacks the subject from the mathematical side, and requires no laboratory work. The knowledge of mathematics which it presumes includes plane trigonometry.

Young Folks' Ideas By the author of "Young Folks' Whys and Wherefores." Illustrated. Philadelphia: J. B. Lippincott & Co. Pp. 243. Price, $2.

This book contains much scientific and technical information, ranging from bread-making and mining to the nature of money and the law of wills, joined by a thin thread of story. Children who care only for stories will not find it hard to skip the useful knowledge, but in following the narrative they will meet with a great many long words, and will have their attention drawn to the vicissitudes of Wall Street, and to that occupation known as "waiting for dead men's shoes." There are good stories which give considerable scientific information, and there are scientific books which are as interesting as any story, but this book belongs to neither class.

An Appeal to Cæsar. By Albion W. Tourgee. New York: Fords, Howard, & Hulbert. Pp. 422. Price, $1.

This is a warm plea for national education of the South. Its points are supported by vigorous arguments, and re-enforced with telling statistics and diagrammatical illustrations. The author begins by attempting to show that the difference in the structure of Northern and Southern society is fundamental—not a merely temporary affair to be wiped out in a few years after the war—but a matter which lay away back of the war, and was its cause; and that under the most favorable circumstances its removal must be the work of a very long time. The difficulty has not been simplified but rather complicated by emancipation, which has brought the two elements of black and white into irrepressible rivalry. This rivalry will not diminish, but will grow with the increase of the colored element, which has been going on, and will continue to go on, with amazing rapidity, while the growth of the white population will be stationary or retrograde. On this matter, while regarding the subject from an opposite point, and with an opposite bias from those of Professor Gilliam (Northern as opposed to Southern), the author quotes approvingly that gentleman's assertion in "The Popular Science Monthly" for February, 1883, that a fusion of the two races is impossible, saying that his conclusion is indisputable "during any period with regard to which speculation may be properly and reasonably extended. Certain it is that the influences now existent will render his words as true a hundred years from now as they are today. What change may possibly be wrought in the tone and sentiment of generations more remote and under circumstances which can not be foreseen, it is, of course, impossible to estimate. . . . We are compelled to indorse his views in this respect almost without the least modification";

and "it is not necessary that the conclusions of Professor Gilliam, in regard to the future of the African race, should be accepted as specifically true. These prognostications do not need to be expressly fulfilled in order to convince any thoughtful mind that the problem of the African race in the United States, instead of being a question that concerns the past alone, is really the most vital and important of all the questions that can possibly occupy the national attention for the present and the future." Judge Tourgee notices the various propositions that have been made of means to meet the evils threatened by this condition of things, and dismisses as impractical and ineffective, all except that of education—of whites and blacks alike—with its liberalizing effects in removing prejudice and promoting culture. He indicates the General Government as the most competent agent for performing the educational work; and his object in publishing this book is to urge that the powers of the Government be turned to this purpose. To make his idea more plain, he sketches a plan under which the administration of the trust shall be confided to a single officer, who shall deal directly with the teachers. The great importance of the subject is obvious. Judge Tourgee's ardent presentment of the case deserves the attention of every citizen.

Fichte's Science of Knowledge. By Charles C. Everett, D. D., Bussey Professor of Theology in Harvard University. Chicago: S. C. Griggs & Co. Pp. 287. Price, $1.25.

This little book, the third of their series of German philosophical classics which the publishers have so far issued, is not a translation, but is an exposition of Fichte's views as presented in his "Grundlage der gesammten Wissenschaftslehre." References are made also to his other writings, in order to show the relation of this work to his whole system. The first chapter gives such information about his life as is deemed helpful in comprehending his philosophy, his relation to Kant is next pointed out, and then the several main points of his philosophy are taken up. Professor Everett closes with a criticism of Fichte, and a comparison of him with Schopenhauer and with Hegel.

PUBLICATIONS RECEIVED.

The Legal Control of Medical Practice by a State Examination. By John B. Roberts, M. D. Philadelphia. Pp. 4.

Modern Railway Facilities. By W. B. Le Van. Philadelphia. Pp. 3.

Relation between the Electromotive Force of a Daniell Cell and the Strength of the Zinc Sulphate Solution. By H. S. Carhart. Pp. 4.

A Method of measuring the Absolute Sensitiveness of Photographic Dry Plates. By William H. Pickering. Pp. 4.

The Educational Influence of the Farm. By William H. Brewer. Pp. 32.

Crossing the Pasture, an Etching. By J. A. S. Monk. New York: Cassell & Co., Limited.

Report of American Association Committee on indexing Chemical Literature. Pp. 3.

Lake Mœris and the Pyramids. By Cope Whitehouse. Pp. 4.

"The Platonist." Edited by Thomas M. Johnson. July, 1884. Orange, N. J. Pp. 16.

Bulletin of the New England Meteorological Society, November, 1884. Pp. 7.

Modern Languages as a College Discipline. By A. M. Elliott. Johns Hopkins University. Pp. 7.

Charts of Relative Storm Frequency for a Portion of the Northern Hemisphere. By John P. Finley. Washington City: Signal-Office. Thirteen charts.

Dominion of Canada. Telegraph and Signal Service Maps. Sir Hector Langevin, Minister of Public Works. Six Sections.

A Combined Visual and Astigmatic Test-Card. By Dr. William S. Little. Philadelphia. Pp. 8.

A Protestant converted to Catholicity by her Bible and Prayer-Book. By Mrs. Fanny Maria Pittar. Buffalo, N. Y.: Catholic Publication Company. Pp. 225.

Measurement of the Force of Gravity at Naha and Kagoshima. By S. Sakai and E. Yamaguchi. Tokio, Japan: Tokio Daigaku. Pp. 22.

Corcoran School of Arts, Columbian University, Washington. Address of Hon. J. W. Powell, LL. D. Pp. 20.

Notes on Ingersoll. By Rev. A. Lambert. Buffalo, N. Y.: Catholic Publication Company. Pp. 203. 25 cents.

List of the Ores and Minerals of Industrial Importance occurring in Alabama. By Eugene A. Smith, State Geologist. Pp. 11.

Dearborn Observatory, Chicago. Annual Report of the Director. Pp. 14.

Transactions of the Vassar Brothers' Institute, and its Scientific Section. Poughkeepsie, N. Y., 1883-'84. Pp. 166.

Land Laws of Mining Districts. By Charles Howard Shinn. Baltimore: S. Murray. Pp. 90.

"Babyhood." Vol. I, No. 1. December. 1884. Monthly. Pp. 32. 15 cents a number; $1.50 a year.

New York Association for improving the Condition of the Poor. Report for 1884. Pp. 61.

"The Sun." Bi-monthly. Vol. I, No. 1. January and February, 1885. Kansas City, Mo.: C. T. Fowler. Pp. 28. 20 cents a number; $1 a year.

Baltimore Dispensary for Nervous Diseases. Report for 1883. Pp. 16.

The Rational Treatment of Chorea. By John Van Bibber. Baltimore. Pp. 8.

Notes on the Opium-Habit. By Asa P. Meylert, M. D. New York: G. P. Putnam's Sons. Pp. 47.

The Extinct Mammalia of the Gulf of Mexico, and other Paleontological Papers; Synopsis of the Species of Oreodontidæ, etc. By Professor E. D. Cope. Philadelphia: A. E. Foote. Pp. 48 and 88. With Plates.

Degeneration the Law of Disease. By L. A. Merriam, M. D. Omaha, Neb.

"The Foreign Eclectic." Part I, French; Part II, German. Pp. 32, each part; monthly. Philadelphia: "Foreign Eclectic Company." 25 cents a part, $2.50 a year for single part, $4 for both parts.

Monsignor Capel's Rejoinder to the Reply of the Rev. J. H. Hopkins, D. D. New York and Cincinnati: F. Pustet & Co. Pp. 74. 25 cents.

Progress in Education. By Mrs. H. F. Wilson. Mobile, Ala. Pp. 12.

What we know of Cholera, etc. By Frank H. Hamilton, M. D. Pp. 27.

A Spectro-Photometric Study of Pigments. By Edward L. Nichols, Ph. D. Pp. 7.

Osteology of Numenius Longirostris. By Dr. R. W. Shufeldt, U. S. Army. Pp. 32, with Plates.

Biographical Notice of Sir William Siemens. By George W. Maynard. Pp. 16.

Hampton Normal and Agricultural Institute. Treasurer's Report for 1884. Pp. 57.

Progress of Chemistry in 1883. By Professor H. Carrington Bolton. Washington: Government Printing-Office. Pp. 31.

Addenda to the Bibliography of Hyper-Space and Non-Euclidean Geometry. By G. B. Halstead. Pp. 6.

Simple and Uniform Method of obtaining Taylor's, Cayley's, and Lagrange's Series. By J. C. Glashan. Ottawa, Canada. Pp. 15.

Allan Dare and Robert le Diable. By Admiral Porter. In Nine Parts. New York: D. Appleton & Co. Pp. about 96. 25 cents each part.

Thermometer Exposure. By H. M. Paul. Detroit, Mich.: W. H. Burr & Co. Pp. 8.

Proposed Plan of a Sewerage System, etc., in Providence, R. I. By Samuel M. Gray. City Document. Pp. 146, with Plates.

Diccionario Tecnológico (Technological Dictionary), English-Spanish. By Nestor Ponce de Leon. No. 9. New York: N. Ponce de Leon. Pp. 64. Price 50 cents.

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Contributions to the Tertiary Geology and Paleontology of the United States. By Angelo Heilprin. Philadelphia: The author. Pp. 117, with Map.

T Lucreti Cari de Rerum Natura. With Introduction and Notes by Francis W. Kelsey. Boston: John Allyn. Pp. 385. $1.75.

Elements of Chemistry. By Professor Sydney A. Norton. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 504.

Prehistoric America. By the Marquis de Nadaillac. Translated by N. D'Anvers. New York: G. P. Putnam's Sons. Pp. 566. $5.

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Book-keeping by Single and Double Entry. By a Book-keeper. New York: D. Appleton & Co. Pp. 100.

A Text-Book of Hygiene. By George H. Rohé, M. D. Baltimore: Thomas Evans. Pp. 324.

The Ornithologist and Oölogist. Vol. IX, 1884. Pawtucket, R. I.: Frank B. Webster. Pp. 152.

Correspondence and Diaries of John Wilson Croker, F. R. S. Edited by Louis J. Jennings. Two volumes. New York: Charles Scribner's Sons. Pp. 584 and 572, with Portrait. Price $5.

In the Lena Delta. By George W. Melville. U. S. N. Boston: Houghton, Mifflin & Co. Pp. 497, with Maps and Illustrations. $2.50.

United States Commission of Fish and Fisheries Report, 1882. Washington: Government Printing-Office. Pp. 1101, with Plates.

Bureau of Ethnology, Second Annual Report, 1880–'81. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 477, with Plates.

Basic Pathology and Specific Treatment of Diphtheria, etc. By George J. Ziegler, M. D. Philadelphia: G. J. Ziegler, M. D. Pp. 225. $2.

Science in Song. By William C. Richards. Boston: Lee & Shepard; New York: C. T. Dillingham. Pp. 131.

The Human Body. By H. Newell Martin and Henry Cary Martin. New York: Henry Holt & Co. Pp. 261. 90 cents.

Representative British Orations, with Introduction and Explanatory Notes. By Charles Kendall Adams. New York: G. P. Putnam's Sons. Three volumes. Pp. 318, 308, 376. $3.75.

POPULAR MISCELLANY.

The Loss of the Lapham Collection.—One of the most serious losses in the recent fire at the Wisconsin State University was the scientific collection made by Dr. I. A. Lapham, and purchased after his death by the State. It consisted of a cabinet containing fossils, minerals, shells, meteorites, and Indian antiquities, 10,000 specimens in all, besides duplicates for exchange; an herbarium of 24,000 specimens, belonging to 8,000 species; and a library of about 1,500 books, pamphlets, and maps. Among the books were many rare volumes. The geological specimens included a large number of fossils peculiar to American formations, and a full series of rocks and fossils illustrating in perfect order and with perfect clearness the geology of Wisconsin. The herbarium embraced the whole range of the vegetable kingdom, with a similar treatment for all examples from the highest to the lowest. Many of the specimens were obtained by exchange from the most eminent botanists in America, England, France, and Germany.

Flowering Plants as Ozone-Generators.—Dr. J. M. Anders has published, in the "American Naturalist," descriptions of experiments he has made in the relations of plant-growth with the generation of ozone. Among the conclusions he has reached are, that the leaves have nothing to do with the production, but that the function resides with the flower; that it lies predominantly in odorous flowers, inodorous flowers being poor generators; and that sunlight, or at least good diffused light, is essential to the production. Hence, it is inferred, during fair weather all flowering vegetation is con-

tributing ozone to the atmosphere; and, as the plants blossom in succession through the season, this source of supply is in constant operation. An interesting phase of the subject is the application of the results of the observations to the question whether plants should be cultivated in living-rooms. As a rule, ozone is not detectable in rooms, because it is constantly decomposed in oxidizing the organic matter that is always present there. But, as flowering plants generate ozone in-doors during clear weather, it can not be doubted that a living-room well stocked with such plants would give off sufficient to be of hygienic value. Important advantages may also be derived from the presence of foliage plants, even though they are incapable of producing ozone, for, if properly taken care of, they will contribute essentially to the maintenance of a hygienic degree of humidity in the atmosphere of the apartment.

The Canker-Worm.—According to Professor Riley's pamphlet on the subject, there are two worms called the canker-worm, both destructive to apple, elm, and maple trees, and much alike. One is called the spring canker-worm, because the moths come out of the ground in the spring; the other, the fall canker-worm. The moths crawl up the tree and deposit their eggs upon the buds, where the larvæ, on being hatched out, begin at once to feed upon the tender leaves. The preventives against their appearance depend largely upon the fact that the female moths are wingless, and can only reach the tree-top by climbing up upon the bark. They consist, therefore, principally in surrounding the trunk of the tree with something in the nature of an obstacle that the worm can not climb by. The trunk may be tarred or greased, or a tin band may be tightly fastened around it. Such appliances are classified by Professor Riley into those which prevent the ascension of the moth by entangling her feet and trapping her fast, or by drowning her; and those which accomplish the same end by preventing her getting a foothold. Other remedies are to jar the trees and burn the worms in straw which has been laid at the bottom to catch them, and applying poisonous washings and dustings to the trees. The worms have parasitic foes, and hosts of industrious enemies among the birds, of which Professor Riley names more than forty species. In New York and Brooklyn they have been exterminated by the English sparrow.

The Condition of the Earth's Interior.—Dr. M. E. Wadsworth has published a review of the various hypotheses concerning the condition of the earth's interior. Physicists, reasoning from mathematical data, suppose it to be solid; but geological phenomena can not be accounted for on that supposition, and various compromises have been proposed to meet the requirements of the case, which are not necessary if it can be shown that the theory of solidity is not well founded. It is suggested that the difficulties alleged by the physicists against the theory of liquidity are of their own making. They have taken premises that no geologist would take, and have claimed to apply points proved regarding these assumed premises as proved for the whole earth. It is not believed to be as yet possible mathematically to prove anything regarding the state of the earth's interior. It is as necessary that physical and mathematical discussions of the subject "should conform to geological facts as it is that geological theories should conform to physical and mathematical laws. It is incumbent on the physicist to explain earthquake-motion, the rising and sinking of different portions of the earth's crust, volcanic phenomena, the uniformity in the composition of lavas, the structure of volcanic rocks, sedimentation, faulting, vein-formation, etc., by his theory of a solid crust." Much depends, in discussing the question of liquidity, upon the possibility of a solid body floating upon a liquid mass of the same substance, concerning which some writers hold that it must sink on account of its greater density, and thus compel solidification from the center. Experiments to test this point have given varying results, but show the possible existence of conditions under which the solid mass would float. Some elements solid are lighter than others liquid. The lighter solid crust would then rest on the denser liquid interior. The transition, moreover, from the solid to the liquid rock, is not sudden, as in the case of

water, but gradual, through every degree of viscosity; and the laws and properties of viscous liquids are different from those of water. Bodies will float on them which under like differences in gravity would sink in water. Now, "when the lighter surface material of the earth had cooled sufficiently, a crust would be formed, which, owing either to its lighter state in the hot condition, or to its scoriaceous character and the viscidity of the material beneath, would not sink." The viscidity of the material immediately under the crust would prevent it sinking, even if it should become heavier and break up; or, if it began to sink, it would be heated and expanded till it became no heavier than the liquid, and would soon reach a point when the liquid, being of different composition, had a higher specific gravity than the crust, and no further sinking could take place. We should thus expect to have formed on the earth's surface a crust which would never sink, or, if it sunk, only for a comparatively short distance, there to give rise to a solid crust floating on a denser heterogeneous liquid. Contractions and upheavals of this crust, not unlike in their effects what we sometimes see take place in ice, would explain all the volcanic and earthquake phenomena that need to be accounted for; while the assumption of a liquid interior accords better with the facts of petrography than any other that has been made. This assumption, according to Dr. Wadsworth's conception, is of "a heterogeneous, viscid, elastic, liquid interior, irregularly interlocked with and gradually passing into a lighter heterogeneous crust."

Value of School Recesses.—Hard as it is to believe, the idea of dispensing with recesses in school has gained so much currency among American teachers, that occasion has been found for bringing in a committee report against it, to the American Council of Education. The advocates of no recess claim that the adoption of their measure will promote the conservation of the health of the pupils, by preventing exposure; that it will tend to refinement by removing the opportunities for rude and boisterous play; that it will take away the opportunity for association with the vicious and consequent corruption of morals; and that it will make things easier for the teachers. The committee find in their report that the exposure to the weather during recess will not hurt, but be beneficial. It gives a change from the close, bad air of the school-room to the free air, with opportunity to relieve physical wants, and affords a means of ventilating the school-room without chilling the scholars; that the "rude and boisterous play" of recess is only a rehearsal of what is indulged in outside of the school-room, with the advantage that the teacher is present to restrain excess, and that it gives needed exercise; that moral corruption is not generated in the open practices of recess, but in secret intercourse; and that the teacher's office is not to make things easy for himself, but by every means in his power to promote the well-being of his pupils.

Experiments with Fog-Particles.—Physicists are divided respecting the mode of constitution of the minute particles of the vapor with which a portion of air becomes clouded when it is cooled and a condensation takes place. According to one view, the invisible vapor resolves itself at the moment of condensation into minute, full, liquid spherules, the aggregation of which produces rain-drops. Other persons suppose that the spherules are hollow and contain air, like soap-bubbles, and designate them as vesicles, while they point to the fact that fog-particles may be observed to rebound from water-surfaces, or from dry bodies, as soap-bubbles do; but full drops of water will do the same under some conditions. One of the strongest objections to the vesicular hypothesis is the difficulty of explaining how the vesicles are formed. It is hard to conceive that, during the vaporization of water, these films of liquid can separate from the surface and at once envelop small volumes of air, so as to form the profusion of microscopic bubbles of which the fog is composed. M. Félix Plateau succeeded, with soap and water, in dashing off thin films of liquid in such a way that a part of the film resolved itself into full drops, while another part gave rise to bubbles. MM. Georges Sire and Minary obtained, by stirring a mixture of olive-oil

and sulphuric acid, a multitude of hollow bubbles that flew around in every direction. The larger bubbles soon fell back into the mixture, but the smaller ones rose rapidly into the air. The floating bubbles developed the play of colors peculiar to their films; when they burst they seemed to set free a mixture of air and sulphurous acid. A magnifying-glass revealed little blisters on the surface of a part of the bubble, indicating a partial separation of the liquids constituting the mixture. When the larger bubbles burst, they gave rise to a local fog composed of spherical particles, which were supposed, but not known, to be hollow. Though these experiments seem to favor the vesicular theory, they do not overcome the difficulty of accounting for the previous formation of the liquid film; and the difficulty is increased when pure water is substituted for the soapy mixture.

Hard Literary Work.—Dr. Riart, a Frenchman, has published a book on hygiene for literary men, that contains some excellent precepts, which literary men will doubtless commend, think it desirable to adopt, and then go on in their old style. Some of the ways of French authors must have severely exercised the highest powers of physical as well as of mental endurance. Littré, during the thirteen years he was composing his dictionary, regulated his life so as to give the least possible time "to the current requirements of existence," and managed to prepare 415,636 pages of manuscript, besides matter for a supplement. He rose at eight o'clock, and wrote for an hour while his room was being arranged. Returning to his room, he read proof till luncheon-time; was at his desk again from one o'clock till six; and, after an hour for dinner, kept on at his work till three o'clock in the morning, or till the task allotted for the day was done, if it was not done then. Everything having been put in order, "my bed," he says, "almost touched my desk, and in a moment I was there." He slept as soundly as a man of leisure, till his regular hour for rising came. This was at his country workshop. In town, his hours were more liable to be broken into. Scribe rose every morning at five, and worked steadily till noon, when he varied his employment by gossiping at the theatres, etc., to put himself in harness later in the day. He lived to be seventy years old, and during his forty years of solid work produced 345 pieces, comprising 897 acts and wrote more than 100,000 verses. Elisée Reclus, according to the London "Spectator," has been occupied for eight years, and expects to be occupied for as much longer time, on his "Universal Geography," He produces a number of the book every week and a volume every year, and has never yet missed being up to time. He works, with a few short intervals for meals and exercise, from seven o'clock in the morning till eight in the evening, is a moderate eater, and has excellent health and capacity for sleep. "He seems to forget nothing, and is always ready to undertake anything, whether it be learning Russian in order the better to write his article on Russia, or making a journey to Syria in search of materials for his chapter on Asia Minor." It is simply method that has enabled these men to do their work so regularly; having once fixed upon a disposition of the time to which the mind and body can conform, what is necessary is to adhere to it and make it a matter of habit. The great thing is to get a good start; for, as Dr. Riart says, "morning work is both the easiest and the most profitable, and, depending as it does upon ourselves, it can be the most regular."

Przevalsky's Wild Horse.—M. Przevalsky, the Russian explorer, brought from his Thibetan expedition a specimen of a hitherto unknown species of wild horse, which has been named, after him, *Equus Przevalsky*. All the genera of the family *Equidæ* known previous to the discovery of this animal were more nearly allied to the genus of asses than of horses, which are distinguished from asses by having warts on the hind-legs as well as on the fore-legs, by their broad, rounded hoofs, and by having long tail-hairs growing from the base and from all parts of the tail, instead of the simple brush of hairs at the end of the tail of the asses. Przevalsky's wild horse appears to be intermediate between the asses and the horses. It has warts on its hind-legs and broad hoofs; but its tail-hairs begin to grow from about half-way down the tail, and not from the base. It differs from the true horse in having a

short, erect mane, with no forelock. Its general color is a whitish-gray, paler and whiter beneath, and reddish on the head. The legs are reddish to the knees, and thence blackish down to the hoofs, and very thick and strong. The head is large and heavy, and the stature of the animal is small. This horse inhabits the great Soongarian Desert, between the Altai and Thian-shan Mountains, and goes in troops of from five to fifteen mares, led by an old stallion. The animals are shy, and of keen senses. It was only possible to secure one specimen, which has been placed in a museum at St. Petersburg.

Evils of Children's Parties.—Dr. Cullimore, of London, has published a protest against children's parties in winter. His objections apply to the collection of children under seven years of age on such occasions. The "Lancet" would extend them to children under twelve. They apply principally to the general effects upon the health of the children, among which are those to which the excitement they have to endure before and after the event renders them liable, the exposure to the danger of chill, and to improper food and drink, and other influences that wear upon the organism at this most tender period of life. Besides these are injuries to the mind and nerves: "A perfect storm of excitement rages in the little brain from the moment the invitation has been received, and the affair is talked about in the nursery until after the evening. Sleep is disturbed by dreams, or, in some cases, prevented by thinking of the occasion, and afterward the excitement does not subside until days have elapsed, perhaps not before another invitation is received." The amusements of young children ought to be simple, unexciting, and free from artificiality. "Parties" are in no way necessary to the happiness of child-life.

Increase of Cancer.—If the data of the registrar-general's reports are correct, cancer is steadily increasing in England, and the rate of increase is augmenting. Thus, during the ten years 1850–1859, the increase in the number of deaths from this disease was 2,000, showing an average increase of about 200; from 1860 to 1869, the number of deaths was 80,049, and the average annual increase 248; and from 1870 to 1879, 111,301 deaths occurred, with an annual increase of 320. Dr. Charles Moore attempted to show, in a book published in 1865, that cancer thrives with good living, and that its increase was an accompaniment of the improved economical condition and vitality of the British people. It abounds where the conditions are ordinarily most favorable to health, and more among the rich than among the poor. According to a French observer, about ten per cent of the wealthy classes and seven per cent of the poorer classes are afflicted with cancer. The disease, according to Dr. Crisp, also prevails among animals, more frequently among flesh-eaters than among herb-eaters, and among domesticated than among wild animals. It is not zymotic or infectious, or conveyed in any way, nor is it transmissible, though the predisposition to it may be inherited; but it begins *de novo* in each individual whom it attacks. The only efficient remedy for it is the surgical one, and that should be applied at the earlier stages of the disease, while the affection is still local.

International Medical Investigation.—Dr. Sir William Gull presented before the recent International Medical Congress at Copenhagen a scheme for an International Collective Investigation of Disease, which is in effect an enlargement of the plan of organized research already in operation with the British Medical Association. The British organization has allotted its work among some fifty sub-committees, in which are included in all some thousand members. One of its methods of work is by the formation of life-histories and family histories of disease, the materials for which are obtained through the family physicians. If such histories could be widely and accurately recorded, the natural associations of different forms of disease in individuals and families would be made evident, and might afford suggestions as to pathological relations not now suspected. In such family histories we might also hope to have elucidated the difficulties of correlated pathologies—"why, for instance, in a numerous family whose members are living under the same conditions, one or two should become the subjects of pulmonary phthisis, one or two the

victims of rheumatism, another of epilepsy, while the others maintain a healthy equilibrium." The clinical subjects which have been selected so far by the British society are acute pneumonia, chorea, acute rheumatism, diphtheria, and inherited syphilis, and information is invited by means of memorandum-cards of inquiry. Several reports have been already gathered on these subjects. The German physicians have selected, for the single subject of their similar investigations, pulmonary phthisis, on which they solicit facts concerning the heredity of the disease, its communicability, its cure, and the transition of pneumonia into phthisis, with many minute particulars respecting family relations. The advantages expected to be derived from making the investigations international are, that it will give them more extent, and will enlist in them minds of varied capacity and habits, and diversified training.

Snail-Culture.—The taste for snails as food is growing in France. The mollusks are regularly cultivated in some of the vine-growing districts of the country, but the greater part of those with which the markets are supplied are raised in the department of Aude. Toward the end of the summer the snails are picked up and collected in small parks which are made in a corner of the garden or field, and are surrounded with an inclosure of sawdust and dry briers, which is stocked with aromatic plants. The park must be regularly visited, particularly in rainy weather, to drive in estrays. Toward the end of the fall, bunches of moss and dry leaves are scattered around, in which the snails may hide themselves after they have closed their shells. The animals are then captured, packed, and sent to market. The ancient Romans cultivated these gasteropods on a quite extensive scale. Their parks were large and surrounded by water, so that the snails could not escape, and an abundant supply of moisture should always be at hand. At fattening-time the animals were put in earthen pots pierced with holes, and rubbed on the inside with flour mixed with wine. Some of them grew to be very large. The Romans liked snails because they provoked thirst, and gave an excuse for drinking wine.

Insect-eating Men.—The insect-eaters here referred to are not occasional persons of depraved tastes, but whole nations, who consume insects on so large a scale as to raise them to a regular article of trade. Locusts are an article of food in parts of Africa, Arabia, and Persia, of such importance that the price of provisions is influenced by the quantity of the dried insects in hand. The Tuaregs of Africa esteem them highly, and a single individual will eat as many as three hundred of them—raw, roasted or stewed—at a meal. Cakes of crushed locusts are a delicacy. Boiled locusts are appreciated in Burmah. Termites and ants are the next most important food-insects. The egg-laden bodies of the females of *Atta cephalotes* are industriously collected by Indians in South America, and the taste of their roasted and salted bodies has been appreciated even by Europeans. The African negroes can hardly get enough of termites, which are eaten fried at the Cape, and in other regions are made into cakes. Roasted termites taste somewhat like marrow or sweet cream. The seventeen-year locust has been eaten in North America, and is said to have been used in soap-making. Cakes are made in Mexico with the eggs of two kinds of water-bugs. A cake made in Fezzan of insect-eggs is described as having the taste of caviare. The Romans were fond of a larva which they called *cossus*. A favorite dish is prepared in Jamaica from the larva of a beetle that lives in the trunks of palm-trees. Another wood-insect is preserved in sugar by the Chinese and Malays, and a liquor is made, with the addition of some water, from a beetle in Mexico. Caterpillars are eaten in Australia and at the Cape, at the risk of woful pains in the stomach, and even spiders, abhorred by every other race, are eaten by the Hottentots and New Caledonians, with the same liability. Worms are accepted as food by very few people. A kind of grub is collected and eaten in Brazil, a nereid worm in Samoa, and a reed-worm by the Ainos of Japan. The Australians around Port Adelaide are said to have lived exclusively on worms and mollusks, while they abhorred beef. Some persons in Naples eat a tape-worm, a parasite of the carp, fried in oil, and call it *macaroni piatti*. Sea-urchins form a quite im-

portant item in the cookery of some lands, and are popular in some of the Mediterranean districts of Europe. Vestiges of them are found among the remains of feasts in Pompeii, and a hundred thousand dozen of them are still sold in the markets of Marseilles every year. They, with holothurias, form important items in the food-consumption of China and Japan, where the people rarely see our butcher's-meat. The holothuria-fishery is carried on extensively in Japan from April to August. The "catch" is consumed fresh on the spot, or is prepared and packed for the Chinese market. Even the Medusa, which no other animal, so far as is known, will eat, is sought for by the Chinese, and used as a dried and salted meat.

Advantages of a Binary Arithmetic.—Mr. H. Farquhar has been discoursing, before the Philosophical Society of Washington, the advantages of a binary arithmetic, or an arithmetic in which the numbers are expressed in powers of two. In the best binary notation he devised, additions required only three fourths of the time taken with the ordinary figures. Had the computer practiced as many weeks with the new notation as years with the old, the difference would have been much more marked, as it was in fact when one unskilled in arithmetic, to whom the binary notation had just been taught, tried the two additions. A great gain in accuracy was also realized; and it is believed that a fair degree of skill in arithmetic, with a binary notation, could be acquired by many to whom readiness is impossible under the present system. The only practicable division of arcs and angles, and the most natural division of all things, is by continued bisections. This is shown by the ratio of value in our coins, weights, and capacity measures, and by the prevalent subdivision of lowest nominal units, as of the carpenter's inch into eighths and sixteenths, and of percentages into quarters, etc., in stock quotations. The American coinage is inconvenient in practice, because of the awkward ratio $2\frac{1}{2}$, which it introduces between several pieces; and there would be the same difficulty in a decimal system of weights and measures, should it be imposed upon us.

Omaha Children.—Miss A. C. Fletcher gave the American Association a pleasing picture of child-life among the Omaha Indians. The little one receives a sacred name, with impressive ceremonies, when it is ten days old, and is always lovingly attended by its father and mother. The cradle is a flat board, to which the child, laid on its back, is fastened, with bandages which are different for boys and for girls; and the pressure of the board against the head causes a flattening of the occiput. The child is kept on the board, with occasional intermissions, in which it is allowed to kick at will, till about the sixth month, when it is put into a hammock. The hair is solemnly cut, in styles peculiar to each gens, at three years of age, when the child may be given a new name. Home-life is made pleasant and attractive to the children with toys, games, and story-telling; and, at a proper age, suitable duties are assigned to the youth: the care of the ponies, the use of the bow and arrow, and the like, to the boys; and the care of the younger children, tilling the ground, dressing the skins, and cooking, in which the maiden must be proficient before she can be considered marriageable, to the girls. Great respect for woman prevails among the Omahas.

Chronology of the Fossil Flora.—Mr. L. F. Ward, at the American Association, reviewed what is known of the fossil flora of the globe. The two oldest known species (*Oldhamia*) have been found in the Cambrian of Ireland. Of the Lower Silurian, forty-four species are known, chiefly of marine algæ; of the Upper Silurian, thirteen; of the Devonian, one hundred and eighty-eight, among which ferns predominate; of the Permo-Carboniferous, nearly two thousand species. Cellular cryptogams of some kind lived in the Laurentian, and account for the graptolite beds found in it. The *Floridæ* (marine algæ), ferns, horse-tail, and club-moss families, begin in the Lower Silurian; the last three families had their maximum in the Carboniferous. The conifers, which reached their maximum in the Cretaceous, began in the Silurian. The cycads had their origin in the Devonian and their maximum in the Middle Jurassic. Monocotyledons began in the Lower Car-

boniferous and flourished most in the Tertiary. Dicotyledons began in the Lower Jurassic, and are enjoying their maximum in the present age. The earliest appearance of them is in the Urogonian of Kome, Greenland.

NOTES.

The Italian Alpine Club is laboring to reafforest the mountains of the peninsula, and is having a measurable degree of success. In 1882 it had made plantations of greater or less extent, which were thriving, on the *Piano del Re*, near the sources of the Po; on Lake Como and Lago Maggiore. Plantations had been made in twenty-eight communes by twenty-one private persons, one of whom alone had set out 15,000 trees. Large plantations were laid out near Sondrio to resist the ravages of the wild mountain brooks. In the Apennines, Professor Magni, rector of the University at Bologna, had planted out 50,000 fir-trees near Spedaletto. These are only beginnings. The club is supported in its work by the people of the north, but the people in the southern part of the peninsula oppose it.

M. de Lacerda has presented to the French Academy through M. de Quatrefages a paper relative to an organism—a fungoid —which he has found abundantly in the organs of persons who have died from yellow fever, and which his experiments have led him to regard as the active agent in the production of that disease. He fortifies his opinion by showing that several peculiarities of coloration displayed by this plant during its growth agree exactly in appearance with the vomited matters and with the color of the liver and the skin. He proposes to make experiments in cultivating the organism and in inoculations with it.

MM. Henry, of the Paris Observatory, have discovered two narrow and parallel bands on Uranus located in a symmetrical relation to the center of the planet's disk. Between them is a bright zone probably corresponding with the equatorial region. The poles are comparatively dark, but the southern pole is lighter than the northern arc. M. Perrotin, of Nice, has been able with his equatorial to follow at intervals the movement of a spot on the planet, and has deduced from it a period of rotation of about ten hours. This agrees well with M. Flammarion's theoretical computation of the period of rotation of Uranus.

Professor Leidy recently called the attention of the Academy of Natural Sciences of Philadelphia to the evidence of the presence of living organisms in ice. What appeared to be living worms had been observed in the sediment taken from a water-cooler. Upon melting some of the ice, Professor Leidy was surprised to find a number of worms among some flocculent sediment, consisting mainly of vegetal hairs and other *débris*, that settled from it. Besides the worms, there were also immature Anguillulas and a number of *Rotifer vulgaris*, all living. It appeared that these animals had all been contained in the ice, and had been liberated on its melting. The worms belonged to the family of *Lumbricidæ*. Dead worms and infusorians were also found.

M. Balbiani has reported, agreeably to a commission given him, to the French Minister of Agriculture, on the best means of destroying the winter eggs of the phylloxera. The three methods in use were all found objectionable; that of rubbing the bark of the vines with steel-chain gloves, because it can only be applied to the old wood; the application of boiling water, because it is likely to be used carelessly; and that of washing the vines with a mixture of oil and coal-tar, because the mixture was too thick in cold weather to be used. M. Balbiani has tried with much success a wash of oil, naphtha, quicklime, and water; and it has the advantage of being cheap.

The story is published, respecting the origin of balloons, that Madame Montgolfier had washed her petticoat to wear to a great festival on the next day, and hung it over a chafing-dish to dry. The hot air, swelling out the folds of the garment lifted it up, and floated it. The lady was astonished and called her husband's attention to the sight. It did not take Montgolfier long to grasp the idea of the hot-air balloon.

Dr. Unna, of Hamburg, has introduced a new medicament which he calls *ichthyol*. It is distilled from a bituminous rock of the Tyrol, the bitumen of which, it is evident from the fossils, is derived from the remains of marine fauna. Ichthyol differs from the coal-tars in its peculiar color and physical properties. It forms an emulsion in water, is partially soluble in ether and in alcohol, and wholly soluble in a mixture of the two liquids. It is very rich in sulphur, containing about ten per cent of that substance, and this makes it very useful in skin-diseases; for, while just as effective, it does not irritate the skin as do other preparations of sulphur. It also contains oxygen, carbon, hydrogen, and traces of phosphorus.

M. Perrotin, director of the observatory at Nice, France, has been enabled by a happy accident, to make an astronomical observation of an earthquake. Being engaged at the moment of the shock in an observation of Hyperion, he observed the Saturnian satellite to make an oscillation of

some fifteen or twenty seconds to the right of his spider-line. It was really, of course, his telescope that moved under the force of a sharp earth-tremor which was duly recorded on the curves of the magnetometer.

The French have formed a society called *Scientia*, for the cultivation of the social qualities among scientific men. Its first banquet was held on the 11th of December, in honor of the ninety-ninth birthday of M. Chevreuil, when M. Jamin, presiding, delivered an appropriate address to the hero of the hour, and M. Chevreuil replied.

Correction.—For Düring read Düsing in the article entitled "Influences determining Sex," published in the January "Monthly."

OBITUARY NOTES.

Arthur Henninger, a French chemist of German birth, died October 4th, in the thirty-fifth year of his age. He studied and labored with Wurtz, and was distinguished for his experiments in the reduction of the polyatomic alcohols, and particularly of erythrite, by formic acid. One of the results of these experiments was the definition of a general method for the reduction of one alcohol to another of less atomicity. He was one of the editors of "Science et Nature."

Dr. Alfred Brehm, author of the "Thierleben," whose death was recently announced, was the son of a Thuringian ornithologist, and devoted his life to the study of all animal nature, but particularly of birds. He spent several years in the northeastern districts of Africa during his younger days, and later made scientific tours in distant lands, including Siberia, Turkistan, and Abyssinia. He was for some years Director of the Zoölogical Gardens at Hamburg.

Mr. R. A. C. Godwin-Austen, F. R. S., an English geological author of well-earned fame, died November 25th. His first geological paper was published in 1835. His favorite topic of study was the changes going on in the present day, especially along the coast. His best-known paper was "On the Possible Extension of the Coal-Measures beneath the Southeastern Part of England." The Geological Society gave him its Wollaston medal in 1862.

The death is announced of Mr. J. Buckman, formerly Professor of Geology and Botany at the Cirencester College, England.

Dr. Bodinus, Director of the Zoölogical Gardens in Berlin, recently died suddenly. He was distinguished, previous to going to Berlin in 1869, in connection with the garden at Cologne.

Dr. Thomas Wright, F. G. S., an English paleontologist, died November 17th. His specialty was fossil echinoderms, concerning the classification and structure of which, and their distribution in the secondary rocks, he contributed much that is important. He was President of the Geological Section of the British Association in 1875.

The death is announced of Henri Lartigue, a French practical electrician. He was born in 1830; served for several years as Professor of Physics, Chemistry, and Natural History in the lycée at Auch, south of France; joined Leverrier at Paris in 1855 to assist him in meteorological observations; and after 1859 was associated with the railroad, telegraphic, and telephonic service, in connection with which he made some valuable inventions. In his youth he made a botanical and entomological exploration of the Pyrenees.

Dr. Augustus Voelcker, the distinguished agricultural chemist, died at Kensington, England, December 5th. He was born at Frankfort-on-the-Main, Germany, in 1823, studied at Göttingen, and became assistant to Professor Johnson, of Edinburgh, in 1849. He was Professor of Chemistry in the Royal Agricultural College at Cirencester from 1852 to 1862, when he became consulting chemist and professor in the Royal Agricultural Society of England. He contributed much to the Agricultural Society's "Journal" and ninety papers to the Royal Society, and he published books on the chemistry of food and the chemistry of manures, and lectures on agricultural chemistry.

Professor Kolbe, author of the "Lehrbuch der organischen Chemie," died November 26th. He was born in Göttingen in 1818, assumed a chair in the London Museum of Economic Geology in 1845, succeeded Bunsen at Marburg in 1851, and accepted a call to Leipsic in 1865. He edited the "Zeitschrift für praktische Chemie" from 1869. He was, shortly before his death, awarded the Davy medal of the Royal Society for his researches in the isomerism of alcohols.

Professor Eugenio Balbi, Professor of Geography at the University of Pavia, died on the 18th of October. He was a son of the celebrated geographer Adriano Balbi, and was born in Florence in 1812.

The death is announced of Mr. Robert Sabine, C. E., an English electrician who has done good work in connection with the applications of electricity. He was a son-in-law of Sir Charles Wheatstone.

Russian science has recently lost by death A. G. Fischer von Waldheim, President of the Moscow Natural History Society.

JEAN LOUIS ARMAND DE QUATREFAGES.

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SCIENCE IN POLITICS.

By F. W. CLARKE.

THE most noteworthy feature of our modern civilization, and the one which distinguishes it from all the civilizations of the past, is its growing dependence upon scientific methods. This is manifested in every department of life, and in every line of thought; it is evident in all arts and industries; and in a multitude of ways it affects government. As modes of living change, the statutory regulation of affairs changes also; as the public thought broadens, methods of administration become broader; as science multiplies the resources of mankind, and brings the nations closer together, legislation recognizes the new condition of the world, and enters upon fields undreamed of a century ago. To-day, every civilized government invokes the aid of science to protect it from enemies, to increase public wealth, and to solve great economic problems; and both science and the state necessarily react upon each other.

The moment we examine closely our own national administration, we find an amazing development in certain lines of scientific industry. Nearly every executive department either has scientific experts regularly connected with it, or employs such experts occasionally for the conduct of important investigations. The work they do is not only "practical," as seen from the most utilitarian point of view, it is also broadly scientific in the highest sense of the term; and it represents in the clearest way the growth of the national intelligence. Some of the investigations relate to the perfecting of national defenses; some to obtaining a better knowledge of the national domain; some to the protection of men and animals against pestilence; and others to the prevention or exposure of certain kinds of fraud. A bare list of the

scientific questions with which an intelligent government has to deal would almost fill a volume; for present purposes, the merest summary must suffice.

Beginning with the defensive branches of our public service, we find that both the army and navy have much to demand of science. At West Point and Annapolis, at public expense, the cadets are taught the elements of science; and these elements, with certain limitations, are afterward professionally applied. In the Ordnance Corps, at the Torpedo Station, etc., men of science are actively engaged upon problems which involve both applications of known facts and explorations into the unknown; and upon the results of their experiments and studies the safety of the nation may depend. The army engineers have to deal with many other scientific questions, such as relate to the building of fortifications, the strength of materials, and so forth; and during times of peace they have also charge of river and harbor improvements throughout the land. These improvements, as at Hell Gate or along the Mississippi, involve applications of rigidly scientific methods, and require familiarity with the latest instrumental improvements. Allied to this work is that of the Hydrographic Office, which perfects the knowledge of our harbors; thus aiding navigation, and at the same time furnishing data which may be available for purposes of defense. The army and navy both maintain strong medical corps; and here, apart from the mere treatment of wounds or diseases, much useful work relating to medical science is done. The nature of an epidemic is investigated, the water-supply of a fort examined, the sanitary condition of a ship regulated, medical statistics accumulated, and so on. In the navy, compasses have to be studied with reference to the magnetic character of their surroundings on shipboard; and an observatory, famous among the observatories of the world, is maintained. Here are found the data necessary for navigation, standard time is furnished, chronometers are rated, and the highest investigations in pure astronomy are carried forward. Finally, both army and navy call upon chemical science to protect them against frauds. Supplies are purchased, either in foods or medicines, iron for ordnance, paints and varnishes for ship-yards, clothing for men, etc.; and the question whether the articles provided are of proper quality is constantly being raised. So analyses are made; and for this purpose each branch of the service maintains laboratories, and chemists are kept continually at work.

Attached to the army, and yet having no definite relations to military work, we find the Weather Service. This fairly represents a class of organizations which protect, not the nation as such, but rather the industries of the people. It warns the ship-owner of a coming storm, or cautions the fruit-grower or sugar-planter against a cold wave, and so assists in making industry surer of a fair return. A similar purpose is fulfilled by the Lighthouse Board, which, attached to the Treasury

Department, attends to the proper illumination of our coasts and rivers. One research of Joseph Henry's upon the oils used for lighthouse lamps saved the Government hundreds of thousands of dollars; and, to-day, the application of the electric light to coast illumination calls for the most careful consideration of scientific experts. The Department of Agriculture also does much in the application of scientific research to the assistance of great industries. It investigates the wasting of our forests, determines the conditions favorable to crops, conducts experiments upon sorghum, studies the plagues which ravage our flocks and herds, and seeks for methods of exterminating insect pests, such as the locust, the cotton-worm, or the potato-beetle. It employs chemists, botanists, entomologists, microscopists, and veterinary surgeons; and their labors can not but be fruitful of much good. Like it in aim, though working in a different direction, is the younger Fish Commission, which restocks our depleted waters, investigates the habits and food of fishes and the best modes of preventing their extermination, and literally creates new sources of wealth for the people.

Under the Treasury Department, in addition to the Lighthouse Board, are several other bureaus which depend more or less upon science. The Mint and Assay Offices, for example, have much to do with chemistry; and, to a certain extent, with physical problems also. The Bureau of Engraving and Printing, which manufactures our national bonds and notes, often has need of assistance from scientific experts; and so too have the custom-houses in the settlement of questions relative to certain duties. The Coast and Geodetic Survey, which is almost purely scientific in character, not only maps our coast-line with the utmost accuracy, but also furnishes the primary triangulation of the interior. This triangulation is the basis for all accurate mapping of the several States, and is done by men of the highest scientific training. An error in the boundary-line between two States may throw doubt upon the transfer, taxation, or inheritance of real property; or, by calling in question the jurisdiction of a court over disputed territories, it may defeat the ends of justice. Hitherto, when such doubts have arisen concerning State boundaries, the United States Government, represented by the Coast Survey, has been the arbiter. This survey also controls our magnetic observatories, in which the variations of the needle are recorded, and has custody of the standard weights and measures. The latter duty is one of the utmost importance, and involves the use of the most delicate instruments of precision.

The Geological Survey is under the Interior Department, and has several functions. It determines the geological structure of the country, joining and completing the scattered details of the several State surveys, develops more fully the principles of geologic science; and, from an economic point of view, investigates our mineral resources.

Its researches tend to increase the value of public lands, and to render the mineral industries of the nation more surely remunerative, productive, and definite. These industries already yield not far from five hundred millions of dollars annually, and accurate knowledge concerning them is essential to intelligent government. For, one function of government is to levy taxes; taxation, in the last analysis, falls upon the resources of a country, and it can not be wisely adjusted unless the resources are well known. A government can not even be truly economical unless its taxes are laid intelligently. Furthermore, the Geological Survey deals with the topography of the country, and prepares detailed maps of great utility. If such maps had been available during the late civil war, our armies would have been spared many difficulties, and the Government would have avoided much expense.

The Patent-Office also comes under the Interior Department; and here again we find great scientific activity, and a large corps of scientific experts. Their duties appear simple enough when superficially stated, but if studied closely they reveal the unexpected fact that the Government really has become the arbiter in doubtful questions of scientific priority. This is especially true in applied chemistry and electricity, and the controversies over the telephone may be cited as cases in point.

Of the other departments of the executive, little need be said. The Post-Office often needs chemical work on paper, fibers, inks, or other supplies. Questions often arise concerning the electric lighting of public buildings; and even the State Department sometimes has to handle matters of international science, as, for example, in the organization of the late conference relative to a common prime meridian of longitude. The Smithsonian Institution need not be considered, inasmuch as it is maintained by a private endowment, of which the United States is merely the trustee; but the National Museum, which is in charge of the Smithsonian regents, may be cited as the repository of valuable public treasures, and as the place in which the material resources of the country are visibly illustrated.

Enough has been said in the foregoing pages, though very incompletely, to indicate what an amount of scientific investigation and experiment our Government is obliged to require. In addition to these labors of an immediately necessary character, other scientific work is frequently carried on at Government expense, which aims at the discovery of truth for its own sake, apart from its direct applications. For examples, the transit of Venus and solar eclipse expeditions may be named, as well as the work carried on by the Bureau of Ethnology. In the latter organization, by Government aid, valuable data are saved which would otherwise be lost to science; and this is as it should be. Too often, in our busy, every-day life, we forget that there can be no applied science unless there is some pure science to apply; and that the larger problems of science, including much of material value to

mankind, are too vast to be grappled by unaided individuals or even by private corporations. They can be solved only by the combined efforts of many trained experts, working with the best facilities and under systematic direction, a state of affairs which can only be brought about by governmental assistance. When that stops, science languishes; and the growth of every industry, public or private, dependent upon science, is checked. Since every modern government is necessarily in competition with other governments, either in the way of increasing its resources or perfecting its means of defense, it follows that aid to science is one of the factors essential to success; and that that nation which fails in far-sighted intelligence will lag behind in material affairs also. Science, both pure and applied, has become a necessity, upon which the welfare and very life of nations must depend. No nation can fairly expect to receive all the benefits of science while giving nothing in return. Even the narrowest utilitarian must see what vast results sprang from the niggardly public grant which rendered possible the first line of the Morse telegraph.

But how shall aid be given? At present, the scientific work of the Government is done in a somewhat scattered way, with more or less overlapping and duplication, and not always under the most favorable circumstances. Some things which ought to be done are neglected, as, for instance, the systematic investigation of pestilences, such as the cholera and yellow fever; others are done twice over by different executive departments acting independently. In the army and navy, apart from the strictly professional researches which the officers are peculiarly fitted to carry on, some scientific work is done in a decidedly amateurish way. Officers are sometimes detailed to make experiments for which they have no special training, and for which civilian experts should be employed; just as if military or naval rank conferred upon its holder an *ex officio* knowledge, applicable everywhere. A naval officer, staff or line, spends three years at sea. He returns to three years of duty on shore, quite rusty as regards pure science, and is ordered to take charge of some laboratory, or to conduct the preparation of some special scientific report. He goes to work as best he may, and after a while his services begin to have real scientific value. Then he is sent to sea again, and some other lately returned victim takes his place. His best efforts are wasted, and science suffers; not because of his fault, but in consequence of a bad system. Fortunately, the system affects only a small part of our scientific services; for both army and navy employ specialists in various lines of investigation: as in the Weather Bureau, the Observatory, the Torpedo Station, and the preparation of the Nautical Almanac. Sometimes, however, it is anything but pleasant to see men of science of established reputation subordinated to some unscientific officer under the supercilious title of "civilian assistants." Full credit and responsibility should be given where they properly belong.

There can be no doubt that the present diffused character of the scientific service is due to the circumstances of its growth. Each feature of it has been developed when and where it was needed, without reference to similar work in other departments; hence the lack of system and the tendency to repetition. But the time for a change seems to be approaching; and it is probable that within a few years the strictly scientific work of the Government will be brought together under systematic control and a common head, and possibly in a new executive department. From such an arrangement the exclusively professional scientific investigations of the army and navy might properly be excepted; leaving whatever relates merely to warfare just where it is now. A department such as is here suggested would consolidate all the national surveys, would contain a national laboratory for the chemical and physical work of the Government, and would control the National Observatory, the Weather Service, and other kindred bureaus. It should be as far removed from political control as are the army, the navy, and the judiciary; its head should be a man of high scientific attainments and tried executive capacity; and each of its chiefs of division should have established reputation in the branch of science with which his duties had to deal. In brief, the officers of a Department of Science should have, relatively to their professions, as high standing as is required in the appointment of Justices of the Supreme Court. On that basis only can the scientific work of the Government attain its maximum efficiency. Although good work is done now, the very best is needed; and the standard can not be set too high. If the proposed consolidation of interests should prove to be not feasible, then some form of affiliation, under guidance of an advisory board of commissioners, might be tried. Either plan would insure greater economy and effectiveness than we have at present, and do away with needless duplications. There may be reasonable differences of opinion as to the best methods of organization; but there is no doubt that improvement is needed.

A discussion of the relations between science and politics, however, covers a broader range than the preceding pages have indicated. That a rational government has need of science, is plain enough; but what return influence does science exert upon the governing power? In what way will the subtile spread of scientific conceptions and methods of thinking affect legislation and government generally? So far we have considered only the material side of the question, but it has an intellectual aspect also, and speculation on this topic is too tempting to be wholly avoided.

As nearly as may be estimated, about forty-five per cent of the members of the present Congress have received a more or less complete college training. This proportion is large enough to show a preference on the part of the people for presumably educated representatives; for the ratio of college-bred men to the mass of any ordinary commu-

nity is vastly smaller. As the poorer and more remote portions of our country become richer and more populous, new colleges will spring up, and the older institutions at the same time are likely to gain in wealth and resources. This condition of affairs will, most probably, lead to an increase in the scholarly element among our legislative bodies; but, be that as it may, another tendency in education more directly concerns our argument. To-day most of our college graduates have received what is known as a "classical" training; in which science, as such, has been allowed to exercise a minimum of influence. But science, nevertheless, is steadily gaining ground; step by step it secures wider recognition and makes a stronger showing in the college courses; and the inevitable result will be that in a few years no man can be considered well educated who has not at least a fair knowledge of some scientific subject. That knowledge, moreover, will have to be gained by modern scientific methods; not from books alone, but by personal observation of things themselves, with the microscope, in the field, or in the college laboratories. In brief, the scholar of the future, whatever else he may have learned, will have received some training in the observation of phenomena at first hand, and in the science of drawing correct conclusions from them. We may, therefore, reasonably expect, as one result of all these tendencies taken together, to see in Congress a steadily increasing number of men acquainted with scientific work, accustomed to scientific modes of thought, and capable of estimating science at its true value, without indifference, and without exaggeration. Such a state of affairs can not fail to exert some influence upon legislation. It will provoke no startling revolutions, and, outwardly, to superficial observers, its effects may be scarcely perceptible; but they will be none the less permanent and real. Both in nature and society the quiet forces are the strongest; and reforms which are brought about almost unconsciously are oftentimes the farthest reaching. The results of a slight change in the mental habits of a Legislature may outweigh the consequences of a war.

Some of the results to be expected from the indicated change are so obvious as to need only the barest mention here. Naturally, the scientific work of the Government would receive more careful attention and be more judiciously fostered than it has been hitherto; its growth would be more symmetrical, and it would come more certainly under competent control. The legislation relating to coinage, weights, measures, etc., would become more intelligent, for the law-making power would be more directly familiar with the principles involved, and prejudices would have diminished influence. Furthermore, every legislative problem to which the scientific method of investigation could fairly be applied would have an increased chance of wise, judicious treatment. Of course, I do not mean to imply that miracles would be wrought, transforming human nature; parties and antagonisms would remain pretty much as they are now; only points of view

would be different, and some of the stumbling-blocks in the way of prudent legislation would have been removed. An argument in favor of definite improvement does not involve a belief in Utopia.

As an example of the problems capable of scientific treatment, let us consider the tariff question. A man who is actively engaged in commerce, manufactures, agriculture, or mining, will, consciously or unconsciously, regard such a problem from the stand-point of his own industry—judging it according to his own interests, and giving less weight to the interests of others. Whatever benefits him must be good for the country ; whatever injures him is surely bad for the country : practical experience and common sense are apparently on his side. Nevertheless, with him, a truly judicial treatment of the subject is so difficult as to be well-nigh impossible ; and this statement is borne out by the existing condition of affairs. Every great industry in the country has either been represented in Congress, or has clamored for relief before it, each asking that certain duties should be raised, and others abolished or lowered. The result of this agitation is practically chaos. Some industries are overburdened, and others are unduly favored ; inequalities appear in every direction ; a fair adjustment seems to be almost unattainable. The tariff, so far, has been framed unsystematically ; the treatment of the question has been unscientific ; hap-hazard experimenting has wrought unmistakable mischief.

Suppose, now, that the tariff problem were brought for solution before men of scientific training. They would look at it much as they would regard a question in mathematics ; as an equation having two sides to be exactly balanced. First, they would group together the objects capable of taxation by import duties, classifying them by a scientific method, and specifying each one with definiteness and precision. The list so formed would next be simplified as much as possible, by striking out repetitions and superfluities, and making as few general headings as would properly cover the ground. Then would follow the consideration of each group by itself, with reference to the amount of revenue needed by the Government, and to the possible prohibitive character of any given rate of duty. Finally, the effects of the tariff upon consumers and producers would be taken into account, and the relations of industries to each other would be carefully studied, so that a duty favorable to one should not be destructive toward another. Thus, step by step, there would be wrought out a tariff system as even and just as possible ; not an ideal system by any means, but one moderate and practicable.

Now, although at first sight it would seem to be a simple matter to adjust such a tariff system, something which any steady-going man of average common sense could attend to, a little consideration will show where the value of a scientific education comes in. First, the rigid application of the method proposed is more likely to be carried out by a man of scientific training than by any other, or at least more

nearly carried out; for the mode of procedure is just that which best fits the solution of scientific problems. The same mental habits are required in both directions; and, other things being equal, the man best trained in such habits will succeed best in handling either class of questions. Secondly, a tariff most directly affects manufactures; for the articles which it considers are either manufactured or used in manufacturing. Nearly every important manufacture of the present day involves applications of science, which ramify from industry to industry in the most complex way. If, therefore, we wish to study intelligently the relations of manufactures to each other, we must bear in mind the principles of the sciences so applied. Or, to speak more moderately and to the point, a knowledge of science is of direct use in attacking the tariff question. Two illustrations may serve to emphasize this argument:

Sulphuric acid is used in vast quantities in various manufacturing industries, and in this country it is mostly made from Sicilian sulphur. Some years ago a committee of Congress, adjusting a tariff, proposed to tax the sulphur, but to admit the acid duty free; the two things being considered separately, and without thought of their industrial relations to each other. Fortunately, the mistake was pointed out and corrected in the committee-room; but, if the error had become law, the production of sulphuric acid in the United States would have been stopped, and every industry using the acid would have been affected. For instance, the manufacturer of fertilizers would be directly concerned in the consequences of such legislation, and through him it would touch the farmers.

My second illustration is of a different kind. When a tariff is to be framed or modified, the old strife between free-trade and protection is renewed. The advocates of the latter policy urge that in the long run protection, by favoring competition, lowers prices and benefits the consumer; and, for evidence, they cite the present cheapness of iron and steel. A man of scientific education, working upon a tariff scheme, would hear this argument, and ask two questions concerning the case in point: First, is the alleged cheapening of iron real, or only apparent and due to a redistribution of ratios? Secondly, if it is real, how much of it has been caused by tariff legislation, and how much by the improvements which science has made in the production of iron? Upon the answers to these questions his final action will depend; for no intelligent estimate of the relations between the tariff and the iron industry could be framed independently of such answers. The fact that science is all the time modifying industrial processes complicates the issue between different tariff systems to an extent which only a man of scientific knowledge can fairly appreciate.

In 1794, during the Reign of Terror, Lavoisier, the greatest chemist of his time and an able statesman as well, was sentenced to the guillotine. Futile attempts were made to secure him a reprieve, in order

that certain important researches, then under way, might be completed; but the appeals in his behalf were met by a brutal reply: "The republic has no need of *savants*." Such was the spirit of ignorance in politics, as opposed to the spirit of science; and yet the event was so recent in history that another distinguished French chemist, Chevreul, who is still living and at work, was then eight years old. Contemporary with Lavoisier, Franklin and Rumford were eminent alike in science and in statesmanship to a degree equaled in either department by very few; and to-day Lyon Playfair, John Lubbock, and Professor Virchow are conspicuous both as investigators and in political life. In Italy, Quintino Sella has been illustrious as geologist, crystallographer, and statesman; and in our own country several men of science have shown their fitness for public affairs, and their capacity for usefulness as legislators. The "scholar in politics" may be out of place from the partisan's point of view, but not from the true statesman's. A closet scholar, who lives only in books, a visionary theorist, or a mere popular lecturer, who reflects the thoughts of others, may lack the qualities which fit a man for dealing with practical measures; but, for the careful scientific investigator who studies things for what they are, with neither fear nor prejudice, a place is surely open. Every one must admit the need of real knowledge, intelligence, and thoughtfulness in parliaments and congresses; and among the statesmen of the future, side by side with the jurist, the diplomat, and the financier, the man of science will stand as a coadjutor and equal. The dictum of the French judge is already reversed: the republic *has* need of *savants*.

THE DARWINIAN THEORY OF INSTINCT.*

By GEORGE J. ROMANES, F. R. S.

"GAVEST thou the goodly wings unto the peacocks? or wings and feathers unto the ostrich? which leaveth her eggs in the earth, and warmeth them in dust, and forgetteth that the foot may crush them, or that the wild beast may break them. . . . Because God hath deprived her of wisdom, neither hath he imparted to her understanding."

This is the oldest theory of instinct. The writer of that sublime monument of literary power in which it occurs observed a failure of instinct on the part of the ostrich, and forthwith attributed the fact to neglect on the part of the Deity; the implication plainly being that in all cases where instinct is perfect, or completely suited to the

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needs of the animal presenting it, the perfection is to be attributed to a God-given faculty of wisdom. This, I say, is the oldest theory of instinct, and I may add that until within the past twenty-five years it has been the only theory of instinct. I think, therefore, I ought to begin by explaining that this venerable and time-honored theory is a purely theological explanation of the ultimate source of instinct, and therefore can not be affected by any scientific theory as to the proximate causes. It is with such a theory alone that we shall here be concerned.

"When giants build, men must bring the stones." For the past eight or ten years I have been engaged in elaborating Mr. Darwin's theories in the domain of psychology, and I can not allude to my own work in this connection without expressing the deep obligations under which I lie to his ever-ready and ever-generous assistance—assistance rendered not only in the way of conversation and correspondence, but also by his kindness in making over to me all his unpublished manuscripts, together with the notes and clippings which he had been making for the past forty years in psychological matters. I have now gone carefully through all this material, and have published most of it in my work on "Mental Evolution in Animals." I allude to this work on the present occasion in order to observe that, as it has so recently come out, I shall feel myself entitled to assume that few have read it; and therefore I shall not cramp my remarks by seeking to avoid any of the facts or arguments therein contained.

As there are not many words within the compass of our language which have had their meanings less definitely fixed than the word "instinct," it is necessary that I should begin by clearly defining the sense in which I shall use it.

In general literature and conversation we usually find that instinct is antithetically opposed to reason, and this in such wise that, while the mental operations of the lower animals are termed instinctive, those of man are termed rational. This rough-and-ready attempt at psychological classification has descended to us from remote antiquity, and, like kindred attempts at zoölogical classification, is not a bad one so far as it goes. To divide the animal kingdom into beasts, fowls, fish, and creeping things, is a truly scientific classification as far as it goes, only it does not go far enough for the requirements of more careful observation; that is to say, it only recognizes the more obvious and sometimes only superficial differences, while it neglects the more hidden and usually more important resemblances. And to classify all the mental phenomena of animal life under the term "instinct," while reserving the term "reason" to designate a mental peculiarity distinctive of man, is to follow a similarly archaic method. It is quite true that instinct preponderates in animals, while reason preponderates in man. This obvious fact is what the world has always seen, just as it saw that flying appeared to be distinctive of birds, and creeping of

reptiles. Nevertheless, a bat was all the while a mammal, and a pterodactyl was not a bird; and it admits of proof as definite, that what we call instinct in animals occurs in man, and that what we call reason in man occurs in animals. This, I mean, is the case if we wait to attach any definition to the words which we employ. It is quite evident that there is some difference between the mind of a man and the mind of a brute, and if, without waiting to ascertain what this difference is, we say that it consists in the presence or absence of the faculty of reason, we are making the same kind of mistake as when we say that the difference between a bird and a mammal consists in the presence or absence of the faculty of flying. Of course, if we choose, we may employ the word "reason" to signify all the differences taken together, whatever they may be; and so, if we like, we may use the word "flying." But in either case we should be talking nonsense, because we should be divesting the words of their meaning, or proper sense. The meaning of the word "reason" is the faculty of ratiocination—the faculty of drawing inferences from a perceived equivalency of relations, no matter whether the relations involve the simplest mental perceptions, or the most abstruse mathematical calculations. And in this, the only real and proper sense of the word, reason is not the special prerogative of man, but occurs through the zoölogical scale at least as far down as the articulata.

What, then, is to be our definition of instinct?

First of all, instinct involves *mental* operation, and therefore implies *consciousness*. This is the point which distinguishes instinct from reflex action. Unless we assume that a new-born infant, for example, is conscious of sucking, it is as great a misnomer to term its adaptive movements in the performance of this act instinctive as it would be similarly to term the adaptive movements of its stomach subsequently performing the act of digestion.

Next, instinct implies hereditary knowledge of the objects and relations with respect to which it is exercised; it may therefore operate in full perfection prior to any experience on the part of the individual. When the pupa of a bee, for instance, changes into an imago, it passes suddenly from one set of experiences to another—the difference between its previous life as a larva and its new life as an imago being as great as the difference between the lives of two animals belonging to two different sub-kingdoms; yet as soon as its wings are dry it exhibits all the complex instincts of the mature insect in full perfection. And the same is true of the instincts of vertebrated animals, as we know from the researches of the late Mr. Douglas Spalding and others.

Again, instinct does not imply any necessary knowledge of the relation between means employed and ends attained. Such knowledge may be present in any degree of distinctness, or it may not be present at all; but in any case it is immaterial to the exercise of the instinct. Take, for example, the instinct of the Bembex. This insect brings

from time to time fresh food to her young, and remembers very exactly the entrance to her cell, although she has covered it with sand, so as not to be distinguishable from the surrounding surface. Yet M. Fabre found that if he brushed away the earth and the underground passage leading to the nursery, thus exposing the contained larva, the parent insect "was quite at a loss, and did not even recognize her own offspring. It seemed as if she knew the doors, nursery, and the passage, but not her child."

Lastly, instinct is always similarly manifested under similar circumstances by all the individuals of the same species. And, it may be added, these circumstances are always such as have been of frequent occurrence in the life-history of the species.

Now, in all these respects instinct differs conspicuously from every other faculty of mind, and especially from reason. Therefore, to gather up all these *differentiæ* into one definition, we may say that instinct is the name given to those faculties of mind which are concerned in consciously adaptive action, prior to individual experience, without necessary knowledge of the relation between means employed and ends attained; but similarly performed under similar and frequently recurring circumstances by all the individuals of the same species.

Such being my definition of instinct, I shall now pass on to consider Mr. Darwin's theory of the origin and development of instincts.

Now, to begin with, Mr. Darwin's theory does not, as many suppose that it does, ascribe the origin and development of all instincts to natural selection. This theory does, indeed, suppose that natural selection is an important factor in the process; but it neither supposes that it is the only factor, nor even that in the case of numberless instincts it has had anything at all to do with their formation. Take, for example, the instinct of wildness, or of hereditary fear as directed toward any particular enemy—say man. It has been the experience of travelers who have first visited oceanic islands without human inhabitants, and previously unvisited by man, that the animals are destitute of any fear of man. Under such circumstances the birds have been known to alight on the heads and shoulders of the new-comers, and wolves to come and eat meat held in one hand while a knife was held ready to slay them with the other. But this primitive fearlessness of man gradually passes into an hereditary instinct of wildness, as the special experiences of man's proclivities accumulate; and, as this instinct is of too rapid a growth to admit of our attributing it to natural selection (not one per cent of the animals having been destroyed before the instinct is developed), we can only attribute its growth to the effects of inherited observation. In other words, just as, in the lifetime of the individual, adjustive actions which were originally intelligent may by frequent repetition become automatic, so in the lifetime of the species, actions originally intelligent may, by frequent repetition and heredity, so write their effects on the nervous system

that the latter is prepared, even before individual experience, to perform adjustive actions mechanically which, in previous generations, were performed intelligently. This mode of origin of instincts has been called by Mr. Lewes the "lapsing of intelligence," and it was fully recognized by Mr. Darwin as a factor in the formation of instinct.

The Darwinian theory of instinct, then, attributes the evolution of instincts to these two causes acting either singly or in combination—natural selection and lapsing intelligence. I shall now proceed to adduce some of the more important facts and considerations which, to the best of my judgment, support this theory, and show it to be by far the most comprehensive and satisfactory explanation of the phenomena which has hitherto been propounded.

That many instincts must have owed their origin and development to natural selection exclusively is, I think, rendered evident by the following general considerations:

1. Considering the great importance of instincts to species, we are prepared to expect that they must be in large part subject to the influence of natural selection. 2. Many instinctive actions are performed by animals too low in the scale to admit of our supposing that the adjustments which are now instinctive can ever have been intelligent. 3. Among the higher animals instinctive actions are performed at an age before intelligence, or the power of learning by individual experience, has begun to assert itself 4. Many instincts, as we now find them, are of a kind which, although performed by intelligent animals at a matured age, yet can obviously never have been originated by intelligent observation. Take, for instance, the instinct of incubation. It is quite impossible that any animal, prior to individual or ancestral experience, can have kept its eggs warm with the intelligent purpose of developing their contents; so we can only suppose that the incubating instinct began in some such form as we now see it in the spider, where the object of the process is protection, as distinguished from the imparting of heat. But incidental to such protection in the case of a warm-blooded animal is the imparting of heat, and, as animals gradually became warm-blooded, no doubt this latter function became of more and more importance to incubation. Consequently, those individuals which most constantly cuddled their eggs would develop most progeny, and so the incubating instinct would be developed by natural selection without there ever having been any intelligence in the matter.

From these four general considerations, therefore, we may conclude (without waiting to give special illustrations of each) that one mode of origin of instincts consists in natural selection, or survival of the fittest, continuously preserving actions which, although never intelligent, yet happen to have been of benefit to the animals which first chanced to perform them. Among animals, both in a state of nature and domes-

tication, we constantly meet with individual peculiarities of disposition and of habit, which in themselves are utterly meaningless, and therefore quite useless. But it is easy to see that, if, among a number of such meaningless or fortuitous psychological variations, any one arises which happens to be of use, this variation would be seized upon, intensified, and fostered by natural selection, just as in the analogous case of structures. Moreover, there is evidence that such fortuitous variations in the psychology of animals (whether useless or accidentally useful) are frequently inherited, so as to become distinctive, not merely of individuals, but of races or strains. Thus, among Mr. Darwin's manuscripts, I find a letter from Mr. Thwaites, under the date of 1860, saying that all his domestic ducks in Ceylon had quite lost their natural instincts with regard to water, which they would never enter unless driven, and that, when the young birds were thus compelled to enter the water, they had to be quickly taken out again to prevent them from drowning. Mr. Thwaites adds that this peculiarity only occurs in one particular breed. Tumbler-pigeons instinctively tumbling, pouter-pigeons instinctively pouting, etc., are further illustrations of the same general fact.

Coming now to instincts developed by lapsing intelligence, I have already alluded to the acquisition of an hereditary fear of man as an instance of this class. Now, not only may the hereditary fear of man be thus acquired through the observation of ancestors—and this even to the extent of knowing by instinct what constitutes safe distance from fire-arms—but, conversely, when fully formed it may again be lost by disuse. Thus, there is no animal more wild, or difficult to tame, than the young of the wild rabbit; while there is no animal more tame than the young of the domestic rabbit. And the same remark applies, though in a somewhat lesser degree, to the young of the wild and of the domestic duck. For, according to Dr. Rae, "if the eggs of a wild duck are placed with those of a tame duck under a hen to be hatched, the ducklings from the former, on the very day they leave the egg, will immediately endeavor to hide themselves, or take to the water, if there be any water, should any one approach, while the young from the tame duck's eggs will show little or no alarm." Now, as neither rabbits nor ducks are likely to have been selected by man to breed from on account of tameness, we may set down the loss of wildness in the domestic breeds to the uncompounded effects of hereditary memory of man as a harmless animal, just as we attributed the original acquisition of instinctive wildness to the hereditary memory of man as a dangerous animal; in neither case can we suppose that the principle of selection has operated in any considerable degree.

Thus far, for the sake of clearness, I have dealt separately with these two factors in the formation of instinct—natural selection and lapsing intelligence—and have sought to show that either of them

working singly is sufficient to develop some instincts. But, no doubt, in the case of most instincts intelligence and natural selection have gone hand in hand, or co-operated, in producing the observed results —natural selection always securing and rendering permanent any advances which intelligence may have made. Thus, to take one case as an illustration. Dr. Rae tells me that the grouse of North America have the curious instinct of burrowing a tunnel just below the surface of the snow. In the end of this tunnel they sleep securely, for when any four-footed enemy approaches the mouth of the tunnel, the bird, in order to escape, has only to fly up through the thin covering of snow. Now, in this case the grouse probably began to burrow in the snow for the sake of warmth, or concealment, or both; and, if so, thus far the burrowing was an act of intelligence. But the longer the tunnel the better would it serve in the above-described means of escape; therefore natural selection would tend to preserve the birds which made the longest tunnels, until the utmost benefit that length of tunnel could give had been attained.

And similarly, I believe, all the host of animal instincts may be fully explained by the joint operation of these two causes—intelligent adjustment and survival of the fittest. For now I may draw attention to another fact which is of great importance, viz., that instincts admit of being modified as modifying circumstances may require. In other words, instincts are not rigidly fixed, but are plastic, and their plasticity renders them capable of improvement or of alteration, according as intelligent observation requires. The assistance which is thus rendered by intelligence to natural selection must obviously be very great, for under any change in the surrounding conditions of life which calls for a corresponding change in the ancestral instincts of the animal, natural selection is not left to wait, as it were, for the required variations to arise fortuitously; but is from the first furnished by the intelligence of the animal with the particular variations which are needed.

In order to demonstrate this principle of the variation of instinct under the guidance of intelligence, I may here introduce a few examples.

Huber observes, "How ductile is the instinct of bees, and how readily it adapts itself to the place, the circumstances, and the needs of the community!" Thus, by means of contrivances which I need not here explain, he forced the bees either to cease building combs, or to change their instinctive mode of building from above downward, to building in the reverse direction, and also horizontally. The bees in each case changed their mode of building accordingly. Again, an irregular piece of comb, when placed by Huber on a smooth table, tottered so much that the bumble-bees could not work on so unsteady a basis. To prevent the tottering, two or three bees held the comb by fixing their front-feet on the table, and their hind-feet on the comb.

This they continued to do, relieving guard, for three days, until they had built supporting pillars of wax. Some other bumble-bees, when shut up and so prevented from getting moss wherewith to cover their nests, tore threads from a piece of cloth, and "carded them with their feet into a fretted mass," which they used as moss. Lastly, Andrew Knight observed that his bees availed themselves of a kind of cement made of rosin and turpentine, with which he had covered some decorticated trees—using this ready-made material instead of their own propolis, the manufacture of which they discontinued; and more recently it has been observed that bees, "instead of searching for pollen, will gladly avail themselves of a very different substance, namely, oatmeal." Now, in all these cases it is evident that, if, from any change of environment, such accidental conditions were to occur in a state of nature, the bees would be ready at any time to meet them by intelligent adjustment, which, if continued sufficiently long and aided by selection, would pass into true instincts of building combs in new directions, of supporting combs during their construction, of carding threads of cloth, of substituting cement for propolis and oatmeal for pollen.

Turning to higher animals, Andrew Knight tells us of a bird which, having built her nest upon a forcing-house, ceased to visit it during the day when the heat of the house was sufficient to incubate the eggs; but always returned to sit upon the eggs at night when the temperature of the house fell. Again, thread and worsted are now habitually used by sundry species of birds in building their nests, instead of wool and horse-hair, which in turn were no doubt originally substitutes for vegetable fibers and grasses. This is especially noticeable in the case of the tailor-bird, which finds thread the best material wherewith to sew. The common house-sparrow furnishes another instance of intelligent adaptation of nest-building to circumstances, for in trees it builds a domed nest (presumably, therefore, the ancestral type), but in towns avails itself by preference of sheltered holes in buildings, where it can afford to save time and trouble by constructing a loosely-formed nest. Moreover, the chimney- and house-swallows have similarly changed their instincts of nidification, and in America this change has taken place within the last two or three hundred years. Indeed, according to Captain Elliott Coues, all the species of swallow on that continent (with one possible exception) have thus modified the sites and structures of their nests in accordance with the novel facilities afforded by the settlement of the country.

Another instructive case of an intelligent change of instinct in connection with nest-building is given from a letter by Mr. Haust, dated New Zealand, 1862, which I find among Mr. Darwin's manuscripts. Mr. Haust says that the Paradise duck, which naturally or usually builds its nest along the rivers on the ground, has been observed by him on the east of the island, when disturbed in their nests upon the

ground, to build "new ones on the tops of high trees, afterward bringing their young ones down on their backs to the water"; and exactly the same thing has been recorded by another observer of the wild ducks of Guiana. Now, if intelligent adjustment to peculiar circumstances is thus adequate, not only to make a whole breed or species of bird transport their young upon their backs—or, as in the case of the woodcock, between their legs—but even to make web-footed water-fowl build their nests in high trees, I think we can have no doubt that if the need of such adjustment were of sufficiently long continuance, the intelligence which leads to it would eventually produce a new and remarkable modification of their ancestral instinct of nest-building.

Turning now from the instinct of nidification to that of incubation, I may give one example to show the plasticity of the instinct in relation to the observed requirements of progeny. Several years ago I placed, in the nest of a sitting Brahma hen, four newly-born ferrets. She took to them almost immediately, and remained with them for rather more than a fortnight, when I made a separation. During the whole of the time the hen had to sit upon the nest, for the young ferrets were not able to follow her about, as young chickens would have done. The hen was very much puzzled by the lethargy of her offspring, and two or three times a day she used to fly off the nest calling on her brood to follow; but, on hearing their cries of distress from cold, she always returned immediately, and sat with patience for six or seven hours more. I found that it only took the hen one day to learn the meaning of these cries of distress; for, after the first day, she would always run in an agitated manner to any place where I concealed the ferrets, provided that this place was not too far away from the nest to prevent her from hearing their cries. Yet I do not think it would be possible to imagine a greater contrast between two cries than the shrill, piping note of a young chicken and the hoarse, growling noise of a young ferret. At times the hen used to fly off the nest with a loud scream, which was doubtless due to the unaccustomed sensation of being nipped by the young ferrets in their search for the traditional source of mammalian nutriment. It is further worthy of remark that the hen showed so much anxiety when the ferrets were taken from the nest to be fed, that I adopted the plan of giving them the milk in their nest, and with this arrangement the hen seemed quite satisfied; at any rate she used to chuck when she saw the milk coming, and surveyed the feeding with evident satisfaction.

Thus we see that even the oldest and most important of instincts in bees and birds admit of being greatly modified, both in the individual and in the race, by intelligent adaptation to changed conditions of life; and therefore we can scarcely doubt that the principle of lapsing intelligence must be of much assistance to that of natural selection in the origination and development of instinct.

I shall now turn to another branch of the subject. From the

nature of the case, it is not to be expected that we should obtain a great variety of instances among wild animals of new instincts acquired under human observation, seeing that the conditions of their life, as a rule, remain pretty uniform for any periods over which human observation can extend. But from a time before the beginning of history, mankind, in the practice of domesticating animals, has been making what we may now deem a gigantic experiment upon the topic before us.

The influences of domestication upon the psychology of animals may be broadly considered as both negative and positive—negative in the obliteration of natural instincts; positive in the creation of artificial instincts. I shall consider these two branches separately, and here I may again revert to the obliteration of natural wildness. We all know that the horse is an easily breakable animal, but his nearest allies in a state of nature, the zebra and the quagga, are the most obstinately unbreakable of animals. Similar remarks apply to the natural wildness of all wild species of kine, as contrasted with the innate tameness of our domesticated breeds. Consider again the case of the cat. The domesticated animal is sufficiently tame, even from kittenhood; whereas its nearest cousin in a state of nature, the wild-cat, is perhaps of all animals the most untamable. But, of course, it is in the case of the dog that we meet with the strongest evidence on this point. The most general and characteristic features in the psychology of all the domesticated varieties are faithfulness, docility, and sense of dependence upon a master; whereas the most usual and characteristic features in the psychology of all the wild species are fierceness, treachery, and self-reliance. But, not further to pursue the negative side of this subject, let us now turn to the positive, or to the power which man has shown himself to possess of implanting new instincts in the mental constitution of animals. For the sake of brevity I shall here confine myself to the most conspicuous instance, which is of course furnished by the dog, seeing that the dog has always been selected and trained with more or less express reference to his mental qualities. And here I may observe that, in the process of modifying psychology by domestication, exactly the same principles have been brought into operation as those to which we attribute the modification of instincts in general; for the processes of artificial selection and training, in successive generations, are precisely analogous to the processes of natural selection and lapsing of intelligence in a state of nature.

Touching what Mr. Darwin calls the artificial instincts of the dog, I may first mention those which he has himself dilated upon—I mean the instincts of pointing, retrieving, and sheep-tending; but, as Mr. Darwin has already fully treated of these instincts, I need not go over the ground which he has traversed, and so shall confine myself to the consideration of another artificial instinct, which, although not men-

tioned by him, seems to me of no less significance—I mean the instinct of guarding property. This is a purely artificial instinct, created by man expressly for his own purposes: and it is now so strongly ingrained in the intelligence of the dog that it is unusual to find any individual animal in which it is wholly absent. Thus, we all know that, without any training, a dog will allow a stranger to pass by his master's gate without molestation, but that as soon as the stranger passes within the gate, and so trespasses upon what the dog knows to be his master's territory, the animal immediately begins to bark, in order to give his master notice of the invasion. And this leads me to observe that barking is in itself an artificial instinct, developed, I believe, as an offshoot from the more general instinct of guarding property. None of the wild species of dog are known to bark, and therefore we must conclude that barking is an artificial instinct, acquired by the domestic dog for the purpose of notifying to his master the presence of thieves or enemies. I may further observe that this instinct of guarding property extends to the formation of an instinctive idea on the part of the animal, of itself as constituting part of that property. If, for instance, a friend gives you temporary charge of his dog, even although the dog may never have seen you before, observing that you are his master's friend and that his master intends you to take charge of him, he immediately transfers his allegiance from his master to you, as to a deputed owner, and will then follow you through any number of crowded streets with the utmost confidence. Thus, whether we look to the negative or to the positive influences of domestication upon the psychology of the dog, we must conclude that a change has been wrought, so profound that the whole mental constitution of the animal now presents a more express reference to the needs of another, and his enslaving animal, than it does to his own. Indeed, we may say that there is no one feature in the whole psychology of the dog which has been left unaltered by the influence of man, excepting only those instincts which, being neither useful nor harmful to man, have never been subject to his operation—such, for instance, as the instinct of burying food, turning round to make a bed before lying down, etc.

I will now turn to another branch of the subject, and one which, although in my opinion of the greatest importance, has never before been alluded to; I mean the local and specific variations of instinct. By a local variation of instinct, I mean a variation presented by a species in a state of nature over some particular area of geographical distribution. It is easy to see the importance of such local variations of instinct as evidence of the transmutation of instinct, if we reflect that such a local variation is obviously on its way to becoming a new instinct. For example, the beavers in California have ceased to make dams, the hyenas in South Africa have ceased to make burrows, and there is a squirrel in the neighborhood of Mount Airy which has

developed carnivorous tastes—running about the trees, not to search for nuts, but to search for birds, the blood of which it sucks. In Ohinitahi there is a mountain parrot, which, before the settlement of the place was a honey-eater, but, when sheep were introduced, the birds found that mutton was more palatable to them than honey, and quickly abandoned their ancestral habits, exchanging their simple tastes of honey-eaters for the savageness of tearers of flesh. For the birds come in flocks, single out a sheep, tear out the wool, and when the sheep, exhausted by running about, falls upon its side, they bore into its abdominal cavity to get at the fat which surrounds the kidneys.

These, I think, are sufficient instances to show what I mean by local variations of instinct. Turning now to the specific variations, I think they constitute even stronger evidence of the transmutation of instinct; for where we find an instinct peculiar to a species, or not occurring in any other species of the genus, we have the strongest possible evidence of that particular instinct having been specially developed in that particular species. And this evidence is of particular cogency when, as sometimes happens, the change of instinct is associated with structures pointing to the state of the instincts before the change. Thus, for example, the dipper belongs to a non-aquatic family of birds, but has developed the instinct, peculiar to its species, of diving under water and running along the bottoms of streams. The species, however, has not had time, since the acquisition of this instinct, to develop any of the structures which in all aquatic families of birds are correlated with their aquatic instincts, such as webbed feet, etc. That is to say, the bird retains all its structural affinities, while departing from the family type as regards its instincts. A precisely converse case occurs in certain species of birds belonging to families which are aquatic in their affinities, these species, however, having lost their aquatic instincts. Such is the case, for example, with the upland geese. These are true geese in all their affinities, retaining the webbed feet, and all the structures suited to the display of aquatic instincts; yet they never visit the water. Similarly, there are species of parrots and tree-frogs, which, while still retaining the structures adapted to climbing trees, have entirely lost their arboreal habits. Now, short of actual historical or paleontological information—which of course in the case of instincts is unattainable, seeing that instincts, unlike structures, never occur in a fossil state—short, I say, of actual historical or paleontological information, we could have no stronger testimony to the fact of transmutation of instincts than is furnished by such cases, wherein a particular species, while departing from the instinctive habits of its nearest allies, still retains the structures which are only suited to the instincts now obsolete.

This last head of evidence—that, namely, as to local and specific variations of instincts—differs in one important respect from all the other heads of evidence which I have previously adduced. For, while

these other heads of evidence had reference to the theory concerning the *causes* of transmutation, this head of evidence has reference to the *fact* of transmutation. Whatever, therefore, we may think concerning the evidence of the causes, it is quite distinct from that on which I now rely as conclusive proof of the fact.

I shall now, for the sake of fairness, briefly allude to the more important cases of special difficulty which lie against Mr. Darwin's theory of the origin and development of instincts. For the sake of brevity, however, I shall not allude to those cases of special difficulty which he has himself treated in the "Origin of Species," but shall confine myself to considering the other and most formidable cases which, after surveying all the known instincts presented by animals, I have felt to be such.

First, we have the alleged instinct of the scorpion committing suicide when surrounded by fire. This instinct, if it really exists, would no doubt present a difficulty, because it is clearly an instinct which, being not only of no use, but actually detrimental both to the individual and the species, could never have been developed either by natural selection or by lapsing intelligence. I may, however, dismiss this case with a mere mention, because as yet the evidence of the fact is not sufficiently precise to admit of our definitely accepting it as a fact.

There can be no such doubt, however, attaching to another instinct largely prevalent among insects, and which is unquestionably detrimental, both to the individual and to the species. I allude to the instinct of flying through flame. This is unquestionably a true instinct, because it is manifested by all individuals of the same species. How, then, are we to explain its occurrence? I think we may do so by considering, in the first place, that flame is not a sufficiently common object in nature to lead to any express instinct for its avoidance; and in the next place by considering that insects unquestionably manifest a disposition to approach and examine shining objects. Whether this disposition is due to mere curiosity, or to a desire to ascertain if the shining objects will, like flowers, yield them food, is a question which need not here concern us. We have merely to deal with the fact that such a general disposition is displayed. Taking, then, this fact in connection with the fact that flame is not a sufficiently common object in nature to lead to any instinct expressly directed against its avoidance, it seems to me that the difficulty we are considering is a difficulty no longer.

The shamming-dead of insects appears at first sight a formidable difficulty, because it is impossible to understand how any insect can have acquired the idea of death or of its intentional simulation. This difficulty occurred to Mr. Darwin thirty or forty years ago, and among his manuscripts I find some very interesting notes of experiments upon the subject. He procured a number of insects which exhibited the instinct, and carefully noted the attitude in which they feigned death.

Some of these insects he then killed, and he found that in no case did the attitude in which they feigned death resemble the attitude in which they really died. Consequently we must conclude that all the instinct amounts to is that of remaining motionless, and therefore inconspicuous, in the presence of danger; and there is no more difficulty in understanding how such an instinct as this should be developed by natural selection in an animal which has no great powers of locomotion than there is in understanding how the instinct to run away from danger should be developed in another animal with powers of rapid locomotion. The case, however, is not, I think, quite so easy to understand in the feigning death of higher animals. From the evidence which I have I find it almost impossible to doubt that certain birds, foxes, wolves, and monkeys, not to mention some other and more doubtful cases, exhibit the peculiarity of appearing dead when captured by man. As all these animals are highly locomotive, we can not here attribute the fact to protective causes. Moreover, in these animals this behavior is not truly instinctive, inasmuch as it is not presented by all or even most individuals. As yet, however, observation of the facts is insufficient to furnish any data as to their explanation, although I may remark that possibly they may be due to the occurrence of the mesmeric or hypnotic state, which we know from recent researches may be induced in animals under the influence of forcible manipulation.

The instinct of feigning injury by certain birds presents a peculiar difficulty. As we all know, partridges, ducks, and plovers, when they have a brood of young ones, and are alarmed by the approach of a carnivorous quadruped, such as a dog, will pretend to be wounded, flapping along the ground with an apparently broken wing in order to induce the four-footed enemy to follow, and thus to give time for the young brood to disperse and hide themselves. The difficulty here, of course, is to understand how the birds can have acquired the idea of pretending to have a broken wing, for the occasions must be very rare on which any bird has seen a companion thus wounded followed by a carnivorous quadruped; and even if such observations on their part were of frequent occurrence, it would be difficult to accredit the animals with so high a degree of reasoning power as would be required for them intentionally to imitate such movements. When I consulted Mr. Darwin with reference to this difficulty, he gave me a provisional hypothesis by which it appeared to him that it might be met. He said that any one might observe, when a hen has a brood of young chickens and is threatened by a dog, that she will alternately rush at the dog and back again to the chickens. Now, if we could suppose that under these circumstances the mother-bird is sufficiently intelligent to observe that, when she runs away from the dog, she is followed by the dog, it is not impossible that the maternal instinct might induce her to run away from a brood in order to lead the dog away from it. If this happened in any cases, natural selection would

tend to preserve those mother-birds which adopted this device. I give this explanation as the only one which either Mr. Darwin or myself has been able to suggest. It will be observed, however, that it is unsatisfactory, inasmuch as it fails to account for the most peculiar feature of the instinct—I mean the trailing of the apparently wounded wing.

The instinct of migration furnishes another case of special difficulty, but, as I have no space to dwell upon the sundry questions which it presents for solution, I shall now pass on to the last of the special difficulties which most urgently call for consideration. The case to which I refer deserves, I think, to be regarded as the most extraordinary instinct in the world. There is a species of wasp-like insect, called the sphex. This insect lays its eggs in a hole excavated in the ground. It then flies away and finds a spider, which it stings in the main nerve-center of the animal. This has the effect of paralyzing the spider without killing it. The sphex then carries the now motionless spider to its nursery, and buries it with the eggs. When the eggs hatch out the grubs feed on the paralyzed prey, which is then still alive and therefore quite fresh, although it has never been able to move since the time when it was buried. Of course, the difficulty here is to understand how the sphex insect can have acquired so much anatomical and physiological knowledge concerning its prey as the facts imply. We might indeed, suppose, as I in the first instance was led to suppose, that the sting of the sphex and the nerve-center of the spider being both organs situated on the median line of their respective possessors, the striking of the nerve-center by the sting might in the first instance have been thus accidentally favored, and so have supplied a basis from which natural selection could work to the perfecting of an instinct always to sting in one particular spot. But more recently the French entomologist, M. Fabre, who first noticed these facts with reference to the stinging of the spider, has observed another species of sphex which preys upon the grasshopper, and, as the nervous system of a grasshopper is more elongated than the nervous system of a spider, the sphex in this case has to sting its prey in three successive nerve-centers in order to induce paralysis. Again, still more recently, M. Fabre has found another species of sphex which preys upon a caterpillar, and in this case the animal has to sting its victim in nine successive nerve-centers. On my consulting Mr. Darwin in reference to these astonishing facts, he wrote me the following letter:

"I have been thinking about Pompilius and its allies. Please take the trouble to read on perforation of the corolla, by bees, page 425, of my 'Cross-Fertilization,' to end of chapter. Bees show so much *intelligence* in their acts, that it seems not improbable to me that the progenitors of Pompilius originally stung caterpillars and spiders, etc., in any part of their bodies, and then observed by their intelli-

gence that if they stung them in one particular place, as between certain segments on the lower side, their prey was at once paralyzed. It does not seem to me at all incredible that this action should then become instinctive, i. e., memory transmitted from one generation to another. It does not seem necessary to suppose that, when Pompilius stung its prey in the ganglion, it intended, or knew, that the prey would keep long alive. The development of the larvæ may have been subsequently modified in relation to their half-dead, instead of wholly dead, prey; supposing that the prey was at first quite killed, which would have required much stinging. Turn over this in your mind, etc."

I confess that this explanation does not appear to me altogether satisfactory, although it is no doubt the best explanation that can be furnished on the lines of Mr. Darwin's theory.

In the brief time at my disposal, I have endeavored to give an outline sketch of the main features of the evidence which tends to show that animal instincts have been slowly evolved under the influence of natural causes, the discovery of which we owe to the genius of Darwin. And, following the example which he has set, I shall conclude by briefly glancing at a topic of wider interest and more general importance. The great chapter on instinct, in the "Origin of Species," is brought to a close in the following words:

"Finally, it may not be a logical deduction, but to my imagination it is far more satisfactory to look at such instincts as the young cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of ichneumonidæ feeding within the live bodies of caterpillars, not as specially endowed or created instincts, but as small consequences of one general law leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live, and the weakest die."

This law may seem to some, as it has seemed to me, a hard one—hard, I mean, as an answer to the question which most of us must at some time, and in some shape, have had faith enough to ask, "Shall not the Judge of all the earth do right?" For this is a law, rigorous and universal, that the race shall always be to the swift, the battle without fail to the strong; and in announcing it the voice of Science has proclaimed a strangely new beatitude—Blessed are the fit, for they shall inherit the earth. Surely these are hard sayings, for in the order of Nature they constitute might the only right. But, if we are thus led to feel a sort of moral repugnance to Darwinian teaching, let us conclude by looking at this matter a little more closely, and in the light that Darwin himself has flashed upon it in the short passage which I have quoted.

Eighteen centuries before the publication of this book—the "Origin of Species"—one of the founders of Christianity had said, in words as strong as any that have been used by the Schopenhauers and Hartmanns of to-day, "The whole creation groaneth in pain and travail." Therefore we did not need a Darwin to show us this terrible truth;

but we did need a Darwin to show us that, out of all the evil which we see, at least so much of good as we have known has come; that if this is a world of pain and sorrow, hunger, strife, and death, at least the suffering has not been altogether profitless; that whatever may be "the far-off divine event to which the whole creation moves," the whole creation, in all its pain and in all its travail, is certainly moving, and this in a direction which makes, if not for "righteousness," at all events for improvement. No doubt the origin of evil has proved a more difficult problem to solve than the origin of species; but, thus viewed, I think that the Darwinian doctrine deserves to be regarded as in some measure a mitigation of the difficulty—certainly in no case an aggravation of it. I do not deny that an immense residuum of difficulty remains, seeing that, so far as we can judge, the means employed certainly do not appear to be justified by the ends attained. But even here we ought not to lose sight of the possibility that, if we could see deeper into the mystery of things, we might find some further justification of the evil, as unsuspected as was that which, as it seems to me, Darwin has brought to light. It is not in itself impossible—perhaps it is not even improbable—that the higher instincts of man may be pointing with as true an aim as those lower instincts of the brutes which we have been contemplating. And, even if the theory of evolution were ever to succeed in furnishing as satisfactory an explanation of the natural development of the former as it has of the natural development of the latter, I think that the truest exponent of the meaning—as distinguished from the causation—of these higher instincts would still be, not the man of science, but the poet. Here, therefore, it seems to me, that men of science ought to leave the question of pain in Nature to be answered, so far as it can be answered, by the general voice of that humanity which we all share, and which is able to acknowledge that at least its own allotment of suffering is not an unmitigated evil.

"For clouds of sorrow deepness lend,
To change joy's early rays,
And manhood's eyes alone can send
A grief-ennobled gaze;

"While to that gaze alone expand
Those skies of fullest thought,
Beneath whose starlit vaults we stand,
Lone, wondering, and untaught."

"We look before and after,
And pine for what is not,
Our sincerest laughter
With some pain is fraught."

Yet still—

"Our sweetest songs are those that tell of saddest thought."

MEDICAL EXPERT TESTIMONY.*

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FROM time to time within the last few years, and perhaps for a longer period, comments have been made in the daily secular press, and occasionally in the medical journals, in reference to the testimony of medical experts, which were anything but flattering to medical men. These comments have, in most cases, had reference to their testimony as experts in cases of alleged lunacy, or in cases involving the question of moral responsibility. They have been charged with ignorance, incompetency, inconsistency, and in some cases with venality. It has been said that their opinions are purchasable.

In support of these grave charges the reader has been referred to the fact that an equal number of eminent experts can usually be found to testify on either side, and that in their testimony they often differ from each other irreconcilably. In other cases no evidence is offered to sustain the charges, except the fact that the opinions of the writer and of the public differ from that of the expert.

In what I shall have to say upon this subject I propose to confine myself to those examples in which the question involved is one of mental capacity and responsibility, as being that in which medical experts have been most often and most severely criticised. To a certain extent, however, you will observe that the arguments employed will apply to expert testimony in any other department of medicine or of science.

1. Medical men, whether they be specialists in the study of mental diseases or not, in the differentiation of the class of diseases now under consideration, labor under peculiar difficulties. There are many mental disorders which are unaccompanied with any recognizable abnormal physical conditions of the brain ; that is to say, in which there are no structural lesions of the brain cognizable during life, or which can be satisfactorily demonstrated in the autopsy ; and there are many in which the mental alienation can not be fairly traced to any lesions in any other part of the body. The number of these examples may hereafter be found to be smaller than is now known, but for the present the fact is as I have stated. That a functional disturbance of the brain exists in such cases is self-evident ; but for aught we know this may be due to some slight molecular, chemical, or vital changes in the nerve-cells of the gray matter of the brain or of a group of cells, not denoted by any peculiar physical signs during life, and which can leave no possible traces after death. To cause mental

* Being a portion of the presidential address on "Medical Expert Testimony, especially in Cases involving the Question of Insanity," delivered before the Society of Medical Jurisprudence and State Medicine (New York), January 8, 1885.

derangement, it may be only necessary that these microscopic cells should be temporarily deprived of their normal supply of oxygen through the vascular system; or, on the other hand, a slight increase in the supply of the proper nutriment or stimulus may cause the same results. A simple loss of equilibrium, or change of tension in the nerve-cell, may cause delirium. These abnormal physical conditions may be temporary or permanent, but in either case they will probably, in the future as in the past, elude the most careful observation of the physician, the chemist, and the microscopist. Science has calculated the vibrations of the musical chord, and measured the oscillations of a ray of light, but has not estimated the vibrations of the living intellectual nerve-cell, nor analyzed its aura which waits incessantly and instantly upon its will. It has furnished no means, therefore, of determining mathematically when the mysterious organ of the mind is out of tune, or why its notes are discordant.

2. Hitherto no one has furnished a definition of insanity which will cover all of the supposed examples. Nor, considering the nature of the subject, is it probable that it will ever be done. It may be easy to differentiate a certain class of cases. We can say, without fear of contradiction, that a raving and uncontrollable maniac is insane, or that another, whose life has been uniformly consistent and harmonious, is sane. But this is not the class of cases in reference to which our opinions are asked. They do not give rise to litigation or dispute. Our opinions are only asked when there exists some room for doubt as to the exact mental condition of the person in question, and who therefore occupies a position near the border-lines which separate insanity from sanity; but no legal or scientific authority has established these lines. They are not indicated by broad rivers, or mountain-ranges, such as form the natural boundaries between nations; but the opposite conditions here become insensibly merged, in such a manner that no one can say where one ends and the other begins. One might as well attempt to determine the exact limits of the auroral lights.

Says Ray, in his classical treatise on "Mental Pathology," "One source, and perhaps the principal, of the prevalent error, is the habit of regarding insanity as a sharply defined phenomenon, easily separated from all accompanying incidents, like an earthquake or a chemical action, instead of a condition arising from obscure beginnings, culminating more or less rapidly, and declining by imperceptible steps, as the darkness of night is succeeded by the light of common day." In these doubtful cases the expert has to consider the possible motives of the individual, his hereditary tendencies, his education, social influences, his previous habits, his condition as to health or disease, and a multitude of other matters, all of which are to be carefully weighed and balanced against each other, before he can form a correct judgment as to whether a certain act or line of conduct implies insanity and irresponsibility or not. That there should not be exact,

or, in many cases, even approximate concurrence of opinion among experts of equal qualifications, is natural and ought to excite no surprise. Those are the unreasonable persons who expect anything else. Of course, it is desirable that there should be no disagreement, since in the decision of so nice a question one grain of testimony, more or less, cast into either scale may decide the life or liberty of the person whose case is before the court; but for the fallibility of human opinions, at least to the extent now supposed, no remedy has as yet been provided.

3. If it be true that expert testimony, when questions of sanity or of moral responsibility are involved, is often contradictory and irreconcilable, it is equally true of expert testimony where questions of much less complexity are involved. It is true in nearly all cases of dispute upon matters of science, art, or commerce. In the Feuardent Di Cesnola suit we have seen one expert in archæology affirm that a piece of statuary was as it came from the hands of the original artist, while another has declared with equal confidence that it was constructed from fragments obtained from different sources. In the investigation which followed the Ashtabula catastrophe, it was ascertained that one man, who was supposed to be both theoretically and practically acquainted with the construction of railroad-bridges, had declared this bridge to have been built according to the most approved system, and that it was perfectly safe, while another expert had expressed a contrary opinion; and this important question was left to be finally and definitively settled when the bridge had given way under the weight of a passing train, and twenty or more lives were lost.

Does it often happen, in any class of cases, that lawyers are unable to obtain expert testimony for their clients, in case they stand in need of it, or that the testimony on the two sides is not conflicting?

Not alone experts, but lawyers also, if we can accept their own statements, do not often agree in opinion as to the merits of the cases of their respective clients. The courts also are far from uniformity in their decisions and their interpretation of the law and the facts.

It has been asked, "If witnesses are not suborned, how does it happen that experts so uniformly testify in the interest of the parties by whom they are employed?" As if it were a question which admitted of but one answer, namely, that the witness gave his testimony under oath, only as a consideration for the pay he was to receive, and without regard to the sanctity of his oath, or to the value of his reputation as a citizen and a man of science.

This question, asked no doubt seriously, will be answered seriously: Because no intelligent lawyer would call an expert witness to the stand until he had ascertained, after a full statement of the case to him, what his opinions were. He would not summon a witness who would certainly, or even possibly, damage the cause of his client.

It is fair to conclude, from the preceding statement of facts, that

the supposed evils of the present system of procuring expert testimony in cases of alleged lunacy have been greatly exaggerated, if they are not wholly imaginary. Such cases are not decided by the experts. Having given their opinions under a direct examination, they are subjected to a sharp cross-examination by skillful attorneys, who subsequently, and after sufficient time has been given for study and reflection, are permitted to argue the case to the jury. The judges comment upon the law and facts relating to the case; and, finally, the jurors, rendered thoroughly familiar with all the points in dispute, and acting independently, render the verdict: and they are better able to do this intelligently than they would have been if there had been *no* discussion.

It is evident also that the supposed evils are not limited to one, but that they extend in an equal degree to all other classes of expert testimony.

Those who are of opinion that the evil is actual and serious have from time to time suggested various remedies.

It has been suggested that experts should be appointed as advisers to the courts, by the State or municipal governments.

Against this method lies the grave objection that the public can have no assurance that the best men would be chosen. The appointing power might be influenced by personal or political motives, rather than by the acknowledged fitness of the person chosen; and it could provide for experts in only one class of cases, since no man could be an expert in all cases in which his services were required.

If it is proposed that the courts should themselves, as occasion might arise, make the appointments, the method would still be liable to the objection that even the courts could not always be relied upon not to make choice of improper men, either because they were uninformed, or entertained personal friendships.

To a certain extent, in cases where the ends of justice plainly demand the exercise of this authority, the courts, or the attorneys who officially represent the courts or the Government, are, under existing laws, permitted to summon expert witnesses; and, in the narrow limits within which this power is now authorized and exercised, it can do no harm. It is only against the exercise of this authority as an exclusive or even general mode of obtaining expert medical testimony, that I desire to record my protest.

In whomsoever the power to make these appointments may be vested, and in whatever manner it may be exercised, and whether the experts may be subject to cross-examination or not, in either case it seems to me liable to work injustice. It happens often that the accused comes into court under the imputation of a verdict of the coroner's jury, and under the adverse influence—more or less—of a presentment or indictment of a grand jury, both of which may be, and usually are, based upon *ex parte* testimony. The State or district attorney is

the representative of these preliminary courts in the prosecution of the accused, and he has already prejudged the case.

It would seem that the State has—in these manifest advantages—all the *ex parte* aid to which it is entitled, or which the ends of justice demand ; but if we now add the testimony of an expert, perhaps not subject to a cross-examination, who has received his appointment from the State or court, and the opinions of the expert chance to be adverse to the accused, the latter enters upon his defense with the additional disadvantage of his case being probably prejudged by the court as well. Thus heavily handicapped, his chance of making a successful defense must be very small indeed.

This method of securing expert testimony seems to me also contrary to the spirit and genius of our institutions, but in harmony with the institutions of the greater part of Europe, where the tendency of governments to concentrate power in themselves, and in the courts, as instruments of the governments, is known and admitted.

In our system of jurisprudence and, I may say, in the Anglo-American system, the personal rights of the citizen are as carefully guarded as those of the State. In the present case the State has certainly its equal share of protection, and by the proposed change it would have more than its just share.

I make no reference to the other means provided by the State for the determination of questions of insanity, such as commissioners in lunacy, etc., because they are in no way connected with the matter now under consideration, namely, the proper method of securing testimony in courts of law.

During my temporary residence in Paris, in 1844, it was a matter of common remark, among medical men and medical students, that Orfila, the celebrated chemist, and the official adviser of the crown in certain matters of expert testimony, had committed a great blunder in a recent case of supposed poisoning by arsenic, and that the error had been detected and exposed by a member of the Academy of Medicine, but that the disclosure of the error came too late to remedy the injustice and harm it had done. He was charged with having been the instrument of like injustice to others, and was frequently spoken of as the "king's executioner."

I do not relate this as reliable history, but only as my recollection of the common gossip of the day ; but, whether the accusations were true or not, they were plainly such as might reasonably be made and justified under a system of jurisprudence in which the professional expert is an appointee of the crown, and is regarded in the light of an official adviser.

In some cases which have come to my knowledge the public has seemed to form its opinion as to the nature and value of the expert testimony solely from the verdict rendered by the jury. In the case of The People against Cole, tried at Albany in 1868, Judge Hogeboom

presiding, the jury rendered a verdict of acquittal on the ground of unsound mind; but no medical expert had testified that Cole was insane. In the course of my examination as an expert witness, the court asked me whether I thought "that Cole, at the time he committed the act for which he was under trial, knew the difference between right and wrong, and that the act was in violation of the law." To which I replied in effect that "Cole, being suddenly confronted by the man who had wronged him, did not probably consider whether the act which he was about to commit was in violation of the law or not." If the jury made use of this reply to pronounce him insane, the responsibility of their verdict does not rest upon me. Their verdict of "unsound mind" was given, as it has been in many similar cases, because they did not think he ought to be punished for the act, and they were quite willing to give a very broad and partial interpretation to any testimony which in the remotest degree seemed to favor the defense. Subsequently, from several sources, I learned that my testimony, inferred only from the verdict, had been subjected to criticism.

The question put to me by the judge, although not so broad as it is usually made, no doubt had in view the legal definition or tests of unsound mind, and which, with a few slight modifications, has been incorporated into most systems of jurisprudence. But no legal definition of unsound mind can ever be properly made; and for the simple reason that no scientific definition is possible. The latter fact has generally been admitted by writers upon mental disease; but, nevertheless, they have often attempted to make what they are pleased to term approximate definitions, for the purpose, as they have declared, of furnishing at least a guide in the proper direction. Upon these approximate definitions the law-makers have constructed their legal definitions or tests; no longer intended as guides simply, but as authoritative and sharply defined distinctions, which the courts are compelled to recognize. Whether these tests be applied in a scientific or legal sense, they are in my opinion unsound, unjust, and confusing; they are calculated to mislead the judgment rather than to direct it to a proper conclusion. They ought, therefore, to be abandoned, and the whole matter left to the common sense of the jurors, aided and enlightened by the testimony, the arguments of the counsel, and the exposition of the courts.

4. While, in what I have said, I trust I have shown a purpose to defend my professional brethren, when appearing in the *rôle* of experts in lunacy, against unjust criticism, by maintaining the undeniable proposition that, other things being equal, they are the most trustworthy witnesses, I am at the same time prepared to say that they are not the only persons or classes of persons whose opinions as experts may be valuable in matters of this sort, or whose opinions might not, in some cases, be safely substituted for their own.

In reference to questions of sanity or insanity, most men of intelli-

gence who have reached adult life are experts. It is, with all of us, the daily practice of our lives to observe and study men's conduct and motives, and we are quick to discover the smallest evidence of mental unsoundness, especially in those with whom we have intimate personal acquaintance. Indeed, in most cases the mental alienation is suspected, or well known, long before the case is brought under the notice of the alienist.

It is not the same, however, in reference to most other subjects in which the services of experts are demanded. It is not so in most matters pertaining to either science, art, commerce, or the general bnsiness of life ; in all of which the average citizen is presumably without experience or knowledge, and without the aid of the expert he could not intelligently perform the duties of a judge or of a juror.

If the question involved were one of mineral or vegetable poisoning, the trial of the case without the assistance of a practical chemist would deservedly expose the court and the law to public contempt.

If, again, it were a question whether the neck of the thigh-bone had been broken within or without the capsule, involving, as this question does, in a great measure, the degree of permanent injury which the patient has sustained, without the aid of an experienced surgeon it would be impossible to place the case fairly before a jury, not one of whom, probably, had ever seen either accident, or knew that they were not identical.

Finally, there is reason to fear that in one direction professed alienists are more liable to err than most other men of learning and experience, but who have not confined their studies so exclusively to the specialty of mental diseases.

It is a fact of common observation that, in all departments of medical science, the specialists to whom our science is indebted for some of its most important improvements and discoveries, are inclined to extend the range or number of diseases and of sympathies referable to the organs of whose lesions they have made a special study. This they do conscientiously, sometimes wisely and sometimes unwisely—their errors being exposed when some other specialist traces the functional disturbance to a lesion of some other organ, or the general practitioner demonstrates that all or nearly all the organs of the body are suffering from a general dyscrasy, and that the lesion of no one in particular can fairly be held responsible for the particular symptoms in reference to the cause and treatment of which the specialist is consulted.

Alienists need to be reminded that they have shown the same tendency to increase the number of diseases under the title of insanity, and to widen the range of their specialty, by including a great many eccentricities and moral obliquities under this title ; and that by so doing they have virtually relieved the subjects of these peculiarities

from responsibility. This is seen in the adoption of the terms monomania, moral insanity, insane impulse, insane delusion, and in the additions made from time to time by writers to the varieties of monomania, among which are placed kleptomania, pyromania, erotomania, theomania, dipsomania, homicidal mania, suicidal mania, etc.

Spitzka, in his recent treatise on "Insanity," which work has at once taken rank among the highest authorities upon this subject, speaking of monomania, says: "Here those alienists who delighted in burdening the infant science of psychiatry with new systems of classification, found a fruitful field for innovation. Whatever the direction in which a lunatic manifested his most prominent symptoms, that direction determined the coining of a new term. . . . The designations 'Gamomania,' or 'the insane desire to marry,' or 'Frauenschuhstehlmonomanie,' or 'the mania for stealing women's shoes,' are imperishable monuments of this folly." To which judicious remarks I will add that, if such acts or mental conditions are to constitute a basis for the classification of insanity, I see no reason why it should not extend to every faculty, sentiment, or emotion of the mind, and to every act of eccentricity or of viciousness which disfigures human conduct.

Rush, the author of "Medical Inquiries and Observations on the Diseases of the Mind," has been quoted as having said that all men were insane on some subject. To the same conclusion it would seem that certain alienists are inclining. If this be true, then the whole matter we have been considering becomes greatly simplified. All men are insane, and all are irresponsible.

It would be unjust to Dr. Spitzka, in whose opinions I have expressed a concurrence, as well as to myself, if I did not state that Dr. Spitzka is willing to retain the name monomania when the use of the term is accompanied with certain reservations and restrictions, "with the limitation that the prefix shall be understood to denote that the insanity extends in a special direction across the mental horizon." He justifies the continued use of the term, but not its abuse.

It is upon this point alone that our opinions diverge. I can not think it advisable to retain the term monomania, or any of the subordinate terms, either for purposes of classification or for the convenience of clinical description. Most alienists are agreed that, even when they use these terms for classification, they do not mean to say that the subject is insane upon only one point, but this is exactly what the term means, if it means anything. It is true that different alienists offer different explanations or definitions of the term, but nearly all admit that it does not mean insanity upon a single subject; and every one must have seen that, with or without explanations, the use of this term by writers and by expert witnesses renders it difficult, if not impossible, for the reader, the public, or the jury to distinguish in many cases between acts of moral obliquity, eccentricity, or viciousness on the one hand, and actual insanity on the other; between responsibility

and irresponsibility. By the multiplication of terms of uncertain meaning they have darkened counsel.

It is liable also, in my opinion, to the further serious objection that it influences, unconsciously but perceptibly, certain alienists to extend unreasonably the limits of the term insanity. I am at least certain that, in this regard, it works mischief in its influence upon the people at large, among whom the word kleptomania and other analogous terms introduced by writers upon mental diseases are in common use, and by whom in most cases they are employed as an apology for crime. I would prefer, therefore, when a man steals and his conduct in other matters shows that he is of unsound mind, that he should be called insane, and not a kleptomaniac; but if he steals, even where the motive may not be apparent, and in all other respects his conduct is consistent, and his mind appears sound, it would be better both for the interests of science and of society that he be called a thief.

HOW FUNGI LIVE IN WINTER.

By BYRON D. HALSTED, Sc. D.

"HARD times" come to most living things. Plants as well as animals have periods when they need to conserve all their energies, husband all their vitality. All vegetation obeys the injunction to multiply and replenish the earth, but with the greatest determination when there are present suffering and impending death. A drought hastens the processes of reproduction, and insufficient nourishment encourages an early if not an abundant fruitfulness. In a climate where hot and cold, or wet and dry, seasons regularly succeed each other, many of our most common economic plants have adapted themselves to these stated changes of outward conditions, and run their course during a single growing season. Such plants constitute that large portion of our vegetation known as the annuals. The great sunflower, that grows into a giant in a single season and defies the summer sun and storm, falls an easy victim to the frosts of autumn. It, however, prepared the way for many successors, in the ripened seeds, each one of which when given favorable conditions will germinate, grow, reproduce its kind, and thus finish another cycle in the realm of vegetable life. The bean-plant, in a different way, climbs its appointed pole, enjoys the same sunshine and shower, produces its blossoms, fills long pods with ripened seeds, and gives up its life like all its fellows in the field. A corn-plant completes its growth in not far from a hundred days, and leaves its accumulated vitality stored up in the grains upon the ear. The prospective life and activity of a whole field of waving corn may be considered as stored up in a few

pecks of apparently lifeless seed-corn safely housed in the granary. We thus see that in the annual plants the life of the species is, so to speak, carried over from one growing season to another in the ripened seed. The seed is also the form in which plant-life is easily transported from place to place. The seed of some hedgerow weed, as it becomes loosened from its attachment upon the lifeless mother-plant, and is blown for rods or even miles over the surface of the incrusted snow, is a familiar and perhaps striking example that may enforce the meaning to be here conveyed. The young plantlet in the seed, snugly packed within thick coats, is preserved from death, and at the same time is carried far from the place where it was produced. The seed is the offspring of the plant and the childhood of its kind, though so fashioned and protected that it can pass safely through a period of drought or cold when its parent would have succumbed. It is the motile or migratory state of plants, and many are the means of transportation by land, wind, wave, stream, passing herd, and flying bird, that are within its reach.

Biennial plants, like the beet, carrot, etc., spend one season in preparing for the coming days of inactivity and exposure, and close their careers the following year by using up the accumulated store of food in the roots, stems, or leaves, in producing a crop of seeds. These plants have taken one bold step toward that perennial condition of life enjoyed by our shrubs, trees, and many other plants. Even the "giants of the forest" prepare themselves for the trying months of winter; by withdrawing their vital fluid from the delicate leaves, and with apparently lifeless branches bearing buds enwrapped in scales and secured with a natural glue, they brave the winter blasts.

The season of growth is constantly anticipating the days when the streams of vitality must be checked. The gardener may remove his tender plants to a place "under glass," and so change the order of Nature that things get "out of season," but soon the tortured plants must have rest from their labors and an opportunity to reproduce their kind.

With this somewhat lengthy introduction to our subject let us enter a less familiar field of plant-life, and see if we do not find the same rule holding true among the minute and frequently very troublesome plants known as Fungi. Enough is not known of the habits of these low forms of vegetation for us to measure the natural limits of individual existence; in fact, individuality is very obscure, and, being largely creatures of circumstance, multiplication is extremely rapid when conditions are most favorable, and at a standstill when the reverse is true. Some of the simplest forms of this vast group, like the minute bacteria, yeast-cells, etc., pass through many generations in a few hours; while, on the other hand, the larger species of the hard, woody "shelf" fungi, on trunks of trees and old stumps, may represent in a single so-called "individual" the accumulated growths of a score or more of years. The mildews, molds, and fungi of that

description are popularly considered as very transient, and as frequently lasting for only a day. They start from a simple body called a spore, produce a network of fine threads, yield a crop of spores in a few hours, and the cycle of life is completed. We, however, find that this round of multiplication is varied, and even these evanescent mildews produce structures which serve the special purpose of carrying the species over trying times of starvation, drought, or cold. The common bread-mold (*Mucor stolonifer*), for example, so abundant upon stale viands in warm, moist weather, forms spore-bearing capsules upon the tips of perpendicular threads, which, when ripe, burst, and the multitudes of minute spores are scattered in all directions by every passing breeze. As the bread begins to get dry, and fails to yield a full supply of nourishment, the mold commences to develop a second form of spore. These are produced by the union of the contents of two filaments (conjugation), as shown in Fig. 1. The two Indian-club-shaped branches are touching, end to end, at *a* and *b*; the union is

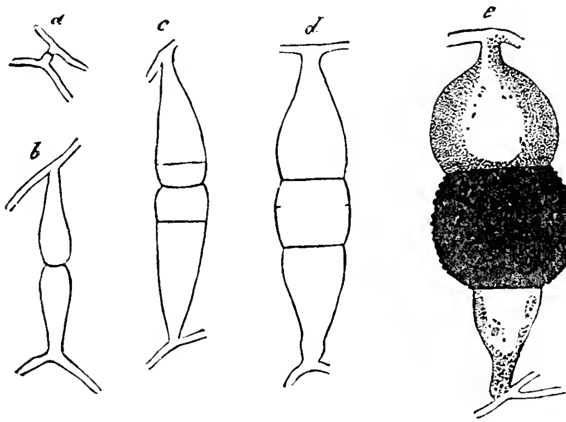
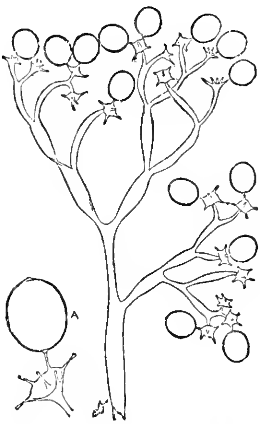


Fig. 1.—Formation of Resting Spores of Bread-Mold.

more advanced at *c*, while at *d* a central cell has formed, containing the mingled contents of the two united cells. At *e* is seen the mature spore, which has a thick, hard, black, and spiny covering, well adapted to protect its highly vitalized contents from all injury. This spore, though magnified ninety times in the engraving, is very much larger than the exceedingly minute sacs of protoplasm formed in the capsules above mentioned. The latter germinate at once, when favorably situated, but the larger black spore remains dormant for a considerable time. Rapid reproduction is provided for in the multitudes of small summer spores, while the preservation of the species is the end sought in the formation of the thick-coated black spores.

Passing from the minute molds that thrive upon bread, cake, etc., we come next to those parasitic species of fungi growing in the tissues of higher forms of plants. The grape-mildew (*Peronospora viticola*)

is a familiar destructive fungus pest that will serve our purpose in an attempt to show the preparation these low forms of plant-life make for passing over hard times, including the winter season. In early summer the lower surface of affected grape-leaves is covered with a minute forest of white filaments. The threads of the fungus run in all directions through the tissue of the leaf, and, coming to the surface, pass through the breathing-pores of the epidermis, and afterward branch and bear oval spores on the tips of the filaments. Fig. 2 represents a small portion of a branch of the lettuce-mildew, which is in the same genus, and closely related to the mildew of the grape. The branch is magnified two hundred times, and the spore A and its attachment are enlarged five hundred diameters. The multitudes of spores borne upon the tips of the branches are for



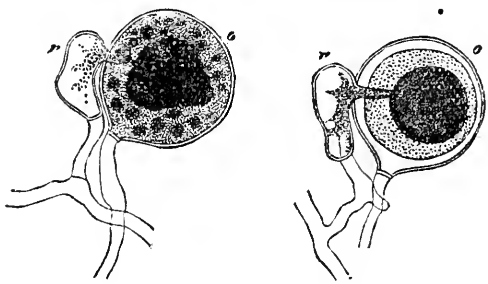


FIG. 2.—BRANCH OF LETTUCE-MILDEW. FIG. 3.—FORMATION OF GRAPE-MILDEW, WINTER SPORE.

the rapid propagation of the mildew. They germinate by producing zoöspores—that is, the contents divide into six or more oval bodies, which soon rupture the spore-wall and escape, each provided with two hair-like appendages termed cilia. These motile zoöspores reproduce the mildew in a new place upon the same or another grape-leaf. Later in the season, and within the substance of the leaf or fruit, a second form of spore is found. This is termed a sexual spore, and requires the union of the contents of two peronospora filaments for its production. One of the thread-tips becomes much enlarged, as shown in Fig. 3, *o* (on the left), which represents the female cell charged with granular protoplasm. Another thread, *n*, arises near by, becomes club-shaped, and applies itself to one side of the female sphere. The contents of the male cell enter and mingle with those of the female, after which the latter matures into a spore. The process of fertilization is further shown in the portion of the engraving on the right, all parts being magnified three hundred and fifty times. The dark central portion is the spore, the contents of which become securely protected by the thick, hard coverings. Unlike the small, thin-walled spores borne upon the tips of the aërial branches, these large sexual spores remain through the winter before germinating. The vitality of the grape-mildew is

concentrated and protected, thus enabling the fungus to survive an exposure that might otherwise prove fatal. It should also be kept in mind that the substance of the leaf in which these spores are imbedded aids in shielding them from harm. If the vineyardist could destroy all these sexual spores at the end of the growing season, he would have little further trouble from the destructive mildew.

The members of the *Cruciferæ*, or cabbage family of plants, are quite generally attacked by white molds—so called because they cover the affected parts with a coating of almost pure white. A much magnified (four hundred times) view of the non-sexual spores is seen in Fig. 4. The white spores are produced in rows, forming be-

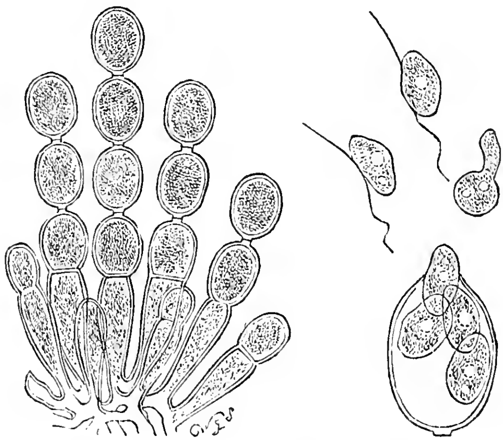


FIG. 4.—SUMMER SPORES OF WHITE MOLDS.

low and falling away from the top, in the simplest possible manner. The contents of the spores divide in germination as in the grape-mildew above described. A ruptured spore is shown one thousand times magnified, in the lower right-hand corner of the figure, while the ciliated protoplasmic bodies (zoöspores) are seen above. These white molds are provided with sexual winter spores very similar to those described for the grape-mildew; in fact, the two groups are closely related, and belong to the same family of fungi. Fig. 5 shows the mature sexual spores of *Cystopus candidus*, magnified four hundred diameters, one of which has its hard shell ruptured and its contents of zoöspores escaping. It requires weeks and even months for the development of these sexual spores, and frequently a long time may elapse before germination takes place. On this account they have received the very appropriate name of resting-spores. They remain within the tissue of the plant, and are frequently liberated only by its decay. The life of the white molds passes over from one season to another in these rough, thick-coated spheres of protoplasm, the formation of which approaches in complexity that of the seeds of higher plants.

The various rusts and brown mildews furnish very complicated methods of propagation, there being no less than four kinds of spores

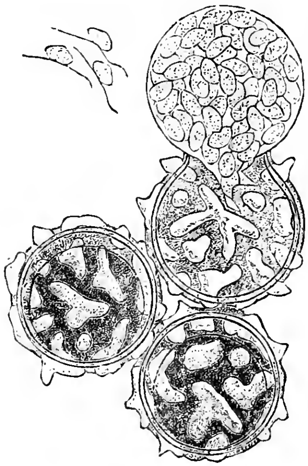


Fig. 5.—Sexual Spores of White Molds.

Fig. 6.—Barberry Leaves with "Cluster-Cups."

produced before the whole life-history of some species is complete. Beginning with the cluster-cup form, found abundantly on the barberry-leaves, as shown in Fig. 6, it is known that the spores from these "cups" produce the common rust upon the wheat leaves and stems. Later in the season another form of spore is formed in the same ruptured patches before occupied by the orange-rust spores. These last spores are double, and form slowly on the tips of slender filaments. Fig. 7 represents a cross-section through a pustule of brown mildew, two hundred times magnified, with the spores congregated beneath the ruptured epidermis. These dark patches and streaks remain until spring. When the spores germinate, as shown in Fig. 8, magnified five hundred times, each twin-spore sends out a filament that bears from three to five small oval bodies, known as *sporidia*.

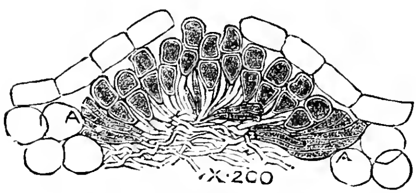


Fig. 7.—Section of Brown Mildew Pustule.

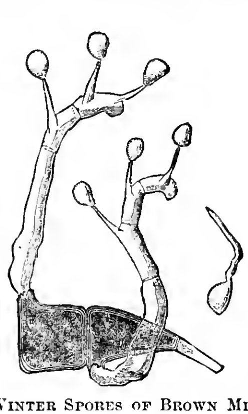


Fig. 8.—Winter Spores of Brown Mildew germinating.

These will germinate on the barberry-leaf and develop the cluster-cups with which we started. It is seen that the rust has ample means for a

rapid propagation of its kind during the growing season, and finally stores up its vitality in dark, thick-coated spores that remain on the stubble through the winter, and are not injured by sudden and severe changes in the weather.

It is due the reader, in passing, to state that one or more of the four forms of spores here briefly mentioned may be omitted. In warm climates it is possible for the winter spores to be dispensed with, the ordinary rust-spores being able to remain alive and continue the life of the pest. It is also believed that in regions unknown to the barberry the cluster-cup form may also be omitted. Like all other living things, the rusts accommodate themselves to circumstances, though watchful that their members do not decrease from any lack of vigilance on the part of these parasites.

The order *Perisporiaceæ* illustrates our subject still further. The members of this group of fungi are mainly parasites upon higher plants, forming a whitish, web-like film over the surface of the affected parts. In the early life of these white mildews, the horizontal threads send up vertical filaments in which partitions rapidly form at regular intervals. The cells thus produced are spores which fall away in succession from the top. A single vertical filament is shown at I, Fig. 9.

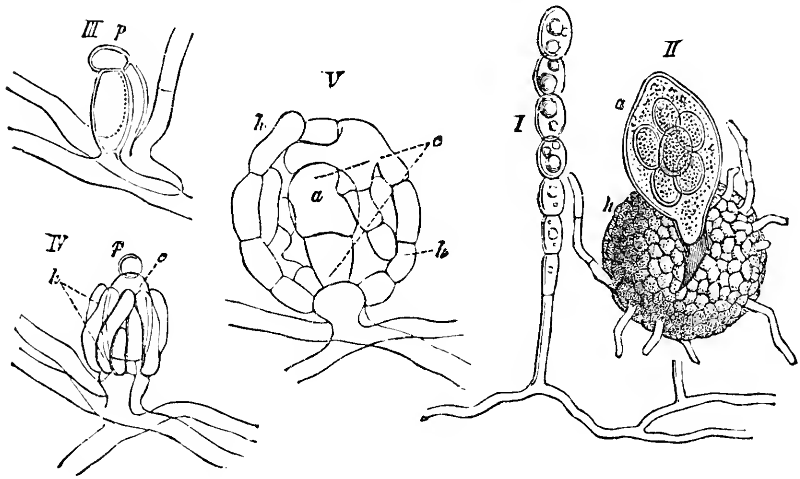


Fig. 9.—Spore Formation of White Mildews.

The spores thus produced are minute, the winds easily disperse them, and they quickly germinate, giving rise to new filaments of mildew. The formation of the sexual or winter spores begins late in the season and is shown in the remaining portions of the engraving. When these spores are to be formed, two filaments, crossing each other as shown at III, send out short projections. One of these, *c*, becomes the female part, and the other, *b*, the male portion. As a result of fertilization, eight or more branches, IV, *h*, grow up from the base and envelop the female cell. These branches continue to grow until a thick, hard cov-

ering is formed. This spore-case is shown more advanced in V. Within, one or more sacs containing spores are formed. At II is seen a mature spore-case which has been ruptured and a sac containing five spores has nearly escaped. It is seen at a glance that the provision made by these species of fungi for the protection of its spores during winter is most complete. Each spore is, doubtless, surcharged with vitality; around it is a sac, and outside of this a thick, hard covering not easily broken. Many of these spore-cases are provided with hooked appendages, by means of which they may hold fast to rough surfaces, and thus the contents are further protected.

The black-knot (*Sphæria morbosa*), so injurious to the plum and cherry trees, furnishes an illustration of another family of fungi, many members of which are considered as perennial. The fungus attacks the young branches, causing them to swell to several times their natural size. The enlarged portion of the branch is made up of a vast number of minute threads, which increase in length and size until the bark of the twig is ruptured in one or more places. An olive-green covering soon forms over the exposed part, consisting of spores borne singly upon the tips of fungus-threads. These simple reproductive bodies quickly pass away and spread the disease to other parts. Later in the season the knot becomes incrusted and a second form of spore is produced, very different in form from the simple oval ones already mentioned. As autumn approaches, the knot assumes a black and rough appearance, indicated in Fig. 10. In the hard crust small pits are formed, in which spores are slowly produced within long, slender sacs. These spores are not ripe until toward spring. In this well-named black-knot we have a fungus with at least three forms of spores, one of which serves the important purpose of carrying the species through the winter season, in a form admitting of a ready dispersion in the early spring. The knots last for more than one season, thus showing that the whole community of fungus-life on a single plum or cherry branch is perennial. This is well shown when a gardener fails to cut away the branch for a sufficient distance below the affected part, in which case the remaining end will develop into a well-formed knot the following season. The filaments of the fungus extend for a foot or more below the swelling, and live on from year to year.

Belonging to the same great group of fungi with the black-knot, but furnishing a different illustration of our subject, is ergot (*Claviceps purpurea*). This fungus attacks the young female portion of the flower of many grasses, and replaces the grain with a hard, irregular mass, several times the size of the unaffected grain. From the resemblance of these grains to the spurs of a cock, and because they are most abundant upon the rye, the fungus has received the common name of "spurred rye." Fig. 11 shows a head of rye, natural size, with four of its grains ergoted. Multitudes of minute spores are produced upon the surface of the affected grain during the growing sea-

son. These, as the reader will naturally infer, are for the rapid propagation of the ergot elsewhere. Usually nothing further in spore-formation takes place until the following spring. The hard, purplish ergot-grains contain no spores, being simply indurated masses of threads containing a very large per cent of oil. This is the winter condition of the fungus. With the warmth of spring and the moisture of the soil upon which the grains may be lying, the horny spurs soften and send out stalks from one or more sides, which have club-shaped extremities bearing multitudes of long, slender spores in minute, pear-shaped sacs. Fig. 12 shows a "growing" ergot-grain in the upper left-hand corner; a cross-section of a head below; a more highly magnified view of a

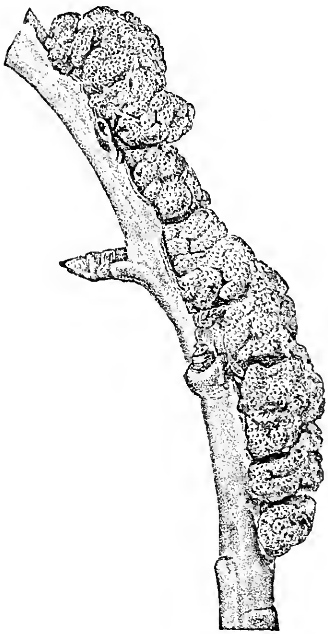


Fig. 10.—A Black Knot.

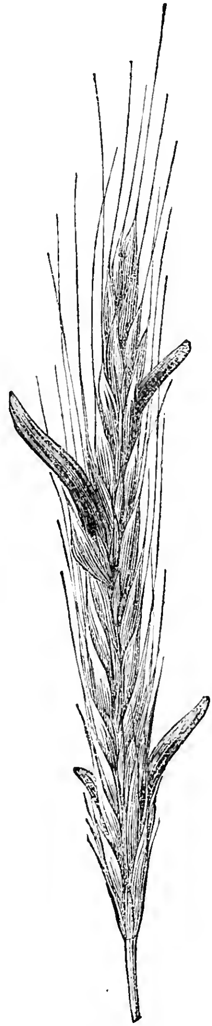


Fig. 11.—Ergoted Rye.

pit on the right, and near the center of the engraving is a single spore-case with the needle-like spores protruding.

The ergot is not alone in assuming a hard condition for the purpose of getting over a severe period of either cold or drought. The term *sclerotia*, meaning *hard*, has long been employed as a name for the compact, resting condition common to many fungi. In the early history of this group of plants, *Sclerotium* was the name of a prominent genus abounding in many so-called species. Now, of course, this

genus has passed away, because founded upon a single condition which any species may assume for self-preservation. The fine threads of various toadstools frequently become joined in long, hard masses, and may be found at the base of almost any decaying stump. It is not unreasonable to suppose that a fungus, otherwise short-lived, may survive the trying circumstances of heat and cold for a score or more of years in this hibernating state.

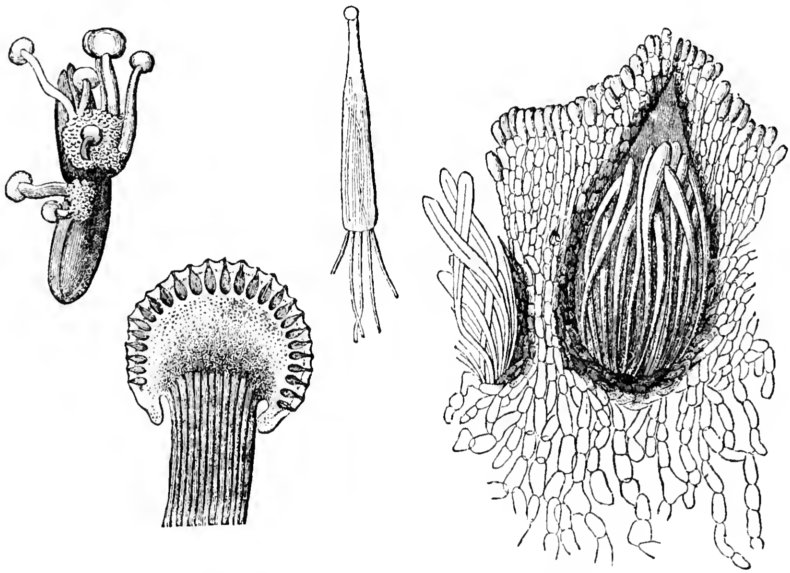


Fig. 12.—Ergoted Grains producing Spores.

The spawn of the common mushroom is a familiar example, to many, of the apparently lifeless condition which the threads of a fungus may assume. This spawn, consisting of the dried filaments of the mushroom, is sold in bricks, and afterward placed in beds which supply the proper heat, moisture, and nourishment for the growth of the edible mushrooms. Yeast, representing the smaller kinds of fungi, can also be kept in dried cakes, ready at an hour's notice to spring into activity and make our bread light and wholesome. It would be interesting to descend lower in the scale of plant organization (if it is lower), and see even among the bacteria, now brought so prominently before the world by the labors of Pasteur and Koch, that these minute organisms, after exhausting the nourishment from a liquid, form a precipitate, which may be regarded as a resting state. Enough, however, has been given to show that fungi, though a humble group of plants, do not lack for methods of rapid increase when favorable conditions prevail, and have abundant means for sustaining life during periods when growth is impossible.*

* The cuts used in this article are re-engraved from Smith's "Diseases of Plants," Bessey's "Botany for High Schools and Colleges," and the Bussey "Bulletin."

CHOLERA.*

BY DR. MAX VON PETTENKOFER.

II. MODES OF PROPAGATION.

HAVING now discussed the relations in time and space which predispose to cholera, I shall pass on to consider those relations in regard to the freedom from cholera which they may enjoin. Places which enjoy an immunity from cholera are more numerous than was formerly supposed, but have been less studied from a point of view of epidemiology, just as relations in time have been but little investigated. The eye of the investigator has only fixed itself on the places where, and at the time when, cholera has reigned. We ought likewise to investigate the matter when and where cholera does not exist. Ordinarily a physician only bestirs himself when he is called to see a case. It has, however, not been so with me. Impressed with these notions, I went in 1868 to the place in Southern France which had enjoyed the greatest and most renowned immunity from cholera. Through the kindness of M. Fauvel, I was introduced to M. Luuyt, of Lyons. Although Lyons was in frequent communication with Marseilles and Paris when epidemics of cholera raged, yet the disease never showed itself in an epidemic form at Lyons. In 1849, for instance, Lyons was besieged, conquered, and invested by troops suffering from cholera. Then the town escaped, while the soldiers suffered severely. This immunity was certainly not due to greater cleanliness of that quarter of the town known as Croix Rousse; nor was it due to the social misery or to the wants of the working-classes; neither had the drainage or water-supply, which prior to 1858 was as bad as it could be, anything to do in the matter. So that the immunity was probably the result of natural conditions. The Lyonese had often congratulated themselves on this excellent gift of nature, but it is probable that the constant movement of air which the combined flow of two great rivers (the Rhône and the Saône) originate is the cause of the immunity, although the mistral (*Mistralstürme*) which scours Languedoc and Marseilles had never been able to drive the cholera away. The situation of Lyons is far different: the bed of the two rivers is composed of compact granite, which on the right bank of the Rhône and on both banks of the Saône rises high, being in places coated with lias, molasse, and thick mud strata. On the heights lie the parts of the town called Croix Rousse, Fourvière, and St. Juste; other quarters lie low—Perroche on a tongue of land between the two rivers, Lyon Vaise on the right bank of the Saône, and Brotteaux and Guillotière on the alluvial soil of the left bank of the Rhône. The lower parts of Lyons

* Reprint of a special translation made for the London "Lancet."

are frequently and deeply flooded over, and yet the cholera never comes!

Just as the disposition to cholera in time and place may be due to two causes, so may the immunity from cholera be dependent either on the physical nature of the soil, as is the case in parts of Traunstein and Kienberg, or on the condition of the soil as regards moisture, as happened in the low-lying parts of Munich during the summer epidemic of 1873, or at Augsburg during the summer and winter of 1873, or at Munich in 1866. Such a degree of wetness as prevailed on those occasions may be a constant condition in some places; to this latter group the low-lying districts of Lyons belong. Indeed, both factors are at work in Lyons. In the high-lying parts the granite comes to the surface in many parts, and so a very efficient and natural drainage is secured. These districts may always be said to be free from cholera. The soil of the low-lying parts, situated on the banks of the Rhône, Brotteaux, Guillotière, and Perroche, has always a certain degree of humidity, which cholera when imported has to encounter. This moisture of the soil of parts of Lyons is dependent not only on rain, but also on the river Rhône. The impermeable bottom of its bed is of solid granite, to which fact I could bear personal testimony. This stratum of granite stretches from the left bank of the Rhône far inward, so that Lyons is built upon it; all the springs lie below the level of the surface of the waters of the Rhône, and so rise and fall with the river. In Paris, in Munich, and in Berlin the conditions are otherwise. Here the level of the subsoil water is above the level of the waters of the Seine, Isar, and Spree, respectively; this relation is the most general, so that Lyons is exceptional. In Lyons it may be said that a part of the Rhône runs subterraneously, so that the soil receives water from the river; whereas in Paris, Munich, and Berlin the direction of the water is constantly from the soil to the river. When the water rises in the beds of the Seine, Isar, and Spree, there is no penetration of the water into the porous soil, but rather a damming and stagnation in the discharge of the subsoil water. The granite of the Rhône, chiefly composed of large blocks of quartz, contains also much fine sand, which is able to suck up water to a considerable height in its capillary spaces, possibly as high as the zone of evaporation. I investigated the hardness and moisture of this quartz by actual digging. This part of Lyons is only at times free from cholera, and would be susceptible of an epidemic were some of its water taken away. That Lyons may be fatally visited was shown in the year of cholera, 1854. As I was studying the conditions of cholera in Lyons, I found that in 1854 no less than 500 deaths occurred from the disease; while at other times the town escaped with a dozen deaths. It also transpired that nearly three fourths of the deaths happened in Guillotière, and I must say, therefore, that in the year 1854 at least a part of Lyons suffered from an epidemic of cholera. The Lyonese were not pleased with this

assertion, because they had always boasted of their immunity from cholera; they replied: "What are 500 deaths out of a population of 400,000? It is absurd to call that an epidemic!" Of course, it would not be right to speak of an epidemic of all Lyons, but most assuredly there existed an epidemic in a part of it. The higher-lying districts had enjoyed their usual immunity in 1854. In the times of cholera which followed 1854 Lyons preserved its freedom. In what respect did 1854 differ from all other years? In nothing but in the fact of its greater dryness. I availed myself of the observations of the meteorological station, and found that in this year the amount of evaporation was greater than the rainfall. Observations on the subsoil water were not to be obtained, but there was the register of the condition of the Rhône dating as far back as 1826. From 1826 to 1854 there was no lower register so lasting as that of the last year. These facts were sufficient to lead me to understand how the lower-lying parts of Lyons could be brought into a condition susceptible of an epidemic of cholera by the partial or total removal of the influence of the Rhône.

That too much as well as too little water in the soil is unfavorable to cholera is vouched for by a large mass of facts. As I watched the cholera in Bavaria during 1854 I was surprised to find that the marshy districts, where, as a rule, the poorest dwelt, were exempt from epidemics. The great Donau bog, which lies between Neuburg and Ingolstadt, was surrounded by the epidemic, but the disease did not enter the villages on the fen. On the Freisinger moors an epidemic occurred at Halbergmoos. On going thither the affected houses were found to stand on a tongue of land composed of quartz, which tongue reached inward on the moor. Reinhard had proved the same thing for Saxony. The northern part of Saxony, which lies on the Spree, is a highly malarious district. For the eleventh time that cholera visited Saxony it shunned this region of fever. I will not say that cholera can not be epidemic on a fen, but I do believe that when such an occurrence takes place we ought to ask ourselves what relation it may have with the state of moisture of the soil. The theory on the soil and subsoil water requires that a knowledge should be obtained of what takes place in and over the soil on the outbreak and on the cessation of cholera. It requires, as Port has said, a continuous record of facts. That cholera should very seldom be met with in the neighborhood of and on mountains is also in harmony with the disposition of cholera in respect of time; so that, as the frequency of cholera in these regions diminishes, the rainfall increases; the weather and cholera are equally capricious. Towns among mountains which are refuges for fugitives from cholera are but seldom situated on a soil which in and of itself would exclude cholera. Salzburg and Innsbrück have, for example, never yet been visited by cholera. Further, in 1866, these towns escaped, although a considerable influx took place from the seat of war where cholera raged. Salzburg, but still more Innsbrück, stands on

the alluvial soil of the Salzbach and the Inn, as Munich stands on the Isar; but the first-named towns have about fifty per cent more rainfall than Munich. I can only imagine that the necessary degree of dryness for the development of cholera would be attained but very rarely in Salzburg and Innsbrück, just as occurred partially at Lyons in 1854, and in June, 1859, at Bombay, where cholera prevailed during the monsoons, which, as a rule, drive the cholera away.

The disposition of cholera in regard to time is also evidenced in the fact that the disease is so different in one and the same place at different times, or at like times in one and the same place, if different parts of the place have different kinds of soil. For instance, in Munich the houses situated on the clay ridge of the suburb of Haidhausen are never affected, but this exemption is certainly not due to the supposed prevention which clay soil in and of itself exerts against the development of the germs of cholera, but because the behavior of rain on clay and rocky soil is very different if the rain be equally distributed over the two kinds of soil. When the rocky soil at Munich was ready for cholera, the clay soil was not.

I shall now leave the arguments for the localists, and pass on to consider the circumstances which are favorable to the views of the contagionists.

That an epidemic of cholera does not permanently last in one place, but after a longer or shorter time ceases, is explained by the contagionists as due to the saturation of the population, whereby each individual acquires a protective influence against cholera similar to that acquired after vaccination as against small-pox and other like instances. This hypothesis does not explain why an epidemic is sometimes rapid and sometimes slow in its course, why it is sometimes vast in its ravages and at other times slight in its effects, while the condition of mankind remains practically the same. With as much reason might the localists assert that the germs of cholera find at different times the local conditions to be favorable or unfavorable with the natural consequences of growth or death. Now, in districts where cholera is endemic, as in the soil of Lower Bengal, it is easy to suppose that at one time the conditions for the multiplication of the germs are present, while at another time the opposite state prevails. The dormant condition of the germs must, for a limited time, frequently exist in districts outside India. This supposition will not explain the occurrence in the low-lying parts of Munich of the severe winter epidemic of 1873–'74, after the summer epidemic in the higher parts of the town had ceased. It follows that we must suppose that the germs which give rise to an epidemic may arrive at a place and there exist for some time (in Munich for three months) without showing any manifestations; and that, indeed, the germs may die before the necessary local conditions for their growth and multiplication are present. So that one might seek in vain to trace the connection between cases of cholera coming

from without and the first cases of illness occurring in a place, as happened in 1883 at Damietta in Egypt, and in 1884 at Toulon in France. The germs may have arrived six months before without finding the necessary material for their growth, and consequently may die out before giving any signs of their existence.

How long the germs of cholera may remain latent in a place we have no evidence to show. There are cases in which we might say that a whole year elapses, but instead of that I think it can be shown that in Europe the germs die out. Since cholera has lasted for many years in Russia, some epidemiologists have supposed that in Russia in the North, just as in Lower Bengal in the South, cholera is endemic. The history of cholera, however, in two islands of the Mediterranean, Malta and Gozo, supplies an example to the effect that the germs of cholera may die out in the space of a few years, and that the germs must be again imported before fresh cases of Asiatic cholera can appear. The Islands of Malta and Gozo lie near one another, and are by nature so similar that it might be imagined that a single homogeneous rock had been split into two parts, a greater and a smaller, which lie as near together as possible in the water without touching one another. It is thus that the two islands project from the sea. Each has the same kind of soil, enjoys the same winds, the same sunshine and rain, the same population of Arabic origin, with like manners, customs, and daily intercourse. Vegetables, fruit, and cattle for slaughter pass daily from Gozo to Malta. The two islands differ in that Gozo has no direct intercourse with the world at large, while Malta is famous for its natural harbor. Both islands have experienced epidemics of cholera, but Malta was always invaded some weeks before Gozo. Finally, both islands show themselves equally susceptible to cholera. In 1865 in Malta 12 per 1,000 of the population, and in Gozo 10 per 1,000, died of cholera. The first case of cholera occurred in 1837 on May 26th in Malta, and on July 5th in Gozo; in 1850 it was June 9th and August 28th respectively. In 1854 and 1856, during the Crimean War, cases of cholera appeared in Malta and Gozo, but not in an epidemic form; nevertheless, sporadic cases first showed themselves in Malta. In the epidemic of 1865 the first case occurred in Malta on June 28th, and in Gozo on July 21st. This interval of time between Malta and Gozo makes me suspicious of the current doctrine that cholera can occur in places two days after the arrival of the infecting cases; for it has not been proved that cases might have arrived still earlier. The instance of Malta and Gozo clearly proves that cholera may have no long duration, that it is not autochthonic, that it is not brought by the wind, but that for its passage intercourse is necessary.

The facts of the influence of locality the contagionists can not deny; indeed, they accept the facts, but explain them in another way. Attempts are made to show by the localists and contagionists, how the germs of cholera spread by means of human intercourse may act

in harmony with the conditions of soil and subsoil water. This is unfortunately still the darkest chapter in the book, and will probably remain so; but it is not darker than the explanation of the nature of another infectious disease, which is equally dependent on conditions of soil and water—namely, malarial fever. We are firmly convinced of its telluric and climatic origin, and yet a study of Von Hirsch's "Handbook on Historio-Geographical Pathology" shows how little we know. Whether the infective material gets to man from the air, or water, or food, or the sting of a gnat, and so forth, we know not; and if we examine the tables showing the appearance of ague in the different months of the year in Leipsic, Vienna, etc., we come to see that the tables are not so very different from those drawn up by Brauser on cholera. In malarial fevers it is doubted whether infection is conveyed by the drinking-water, whereas contagionists believe that cholera is propagated through this source. The drinking-water theory played a great part in the causation of epidemics in the middle ages; it was believed that wicked men, either Jews or Christians, had poisoned the springs from which death was drunk. For good health, pure water is as necessary as pure air, good food, comfortable quarters, and so forth. I myself am an enthusiast in the matter of drinking-water, but not from fear of cholera or typhoid fever, but simply from a pure love for the good. For the water is not only a necessary article of food, but a real pleasure, which I prefer, and believe to be more healthful than good wine or good beer. When water fails, man may suffer not only from cholera, but from all possible diseases. In places where cholera prevails the water may always be indicted, for the water-supply is always a part of the locality, and the doctrine will frequently hold good, because the part may be mistaken for the whole. Where the influence of the water is held up to the exclusion of all other local factors error is liable to creep in. In England, where the drinking-water theory is fully believed in, two like influences, in which every other local factor was excluded, were observed in the cholera epidemic of 1854. In one case, in a street in London which was supplied by two water companies, the Lambeth with pure water, and the Vauxhall with impure water, it was found that the cholera was practically limited to the houses supplied by the Vauxhall Company. I was so much impressed by this fact that I endeavored to see whether the epidemic of 1854 in Munich could not be explained on a similar hypothesis. But my researches led me to a negative result. Without doubting the facts observed in London, I am of opinion that the impure water of the Vauxhall Company did not spread the germs of cholera, for the propagation of cholera was not effected by this means in Munich, but that the water increased either the personal predisposition to cholera, or perhaps the local predisposition, since the water would be employed in the houses, and about the soil. Later on, in 1866, Letheby doubted the accuracy of the drinking-water theory, and

proved that there had been considerable confusion ; so that a house which was registered on the Lambeth Company, really drew its water-supply from the main of the Vauxhall Company, and *vice versa.* The cholera epidemic of 1866 was essentially limited to East London. The East London Water Company supplied this district with water filtered from the river Lea. Letheby brought forward a series of facts to prove that we might with equal justice accuse the East London Gas Company, since the first case of cholera broke out at the gas-factory. A second instance in London was that with which the name of Dr. Snow is associated. Golden Square, a part of London with very deficient drainage, was the scene of a severe epidemic of cholera in 1854. The epidemic concentrated itself in Broad Street. There must have been some reason for this, and the reason must be discovered. Where Golden Square and Broad Street stood was formerly a place of burial for individuals dead of the plague. This pest-blast of a former century could walk from its grave in A. D. 1854 like the ghost in "Hamlet." But a narrower inspection proved that the old pest-field and the new cholera-field were not exactly coextensive. Now, however, another fact was brought to light, which led to the substitution of the drinking-water as the cause. In the middle of Broad Street there stood a pump of which the water was much esteemed on account of its freshness. At the end of August, while the cholera was raging, it was found out that many sufferers had drunk of the pump-water, but the fact was not sufficiently decisive, and so a pathological experiment was required. In Broad Street there was a percussion-cap factory belonging to Mr. Eley. The persons of this establishment suffered from cholera, and many of them died. Mr. Eley remained well, but he did not live at the factory, though he went there daily and returned home to Hampstead after business, and there lived with his mother and a niece. His mother, who formerly lived in Broad Street, had a great liking for the water of the pump-well, which was shown in the fact that her son daily took home the water for his mother and niece. In Hampstead there had been no case of cholera until the mother and daughter fell ill and died of cholera, without having any other communication with Broad Street than through the means mentioned. What more is wanted? Who can doubt any longer? An experiment on two human beings with a disease which animals are not susceptible to! A sad privilege. Never before had facts received a more frivolous interpretation. Suppose, for a moment, that Mr. Eley had gone to and from Hampstead to Broad Street without having taken the water to his mother and niece ; and, further, that they had become ill of the cholera without having drunk the pump-water, would it have been imagined that the cholera had been carried by the son, who remained in good health? The contagionists would probably reply that Mr. Eley may have had the cholera in a mild form. The localists would say that a poison locally originated might be passed on by healthy people without

giving signs of illness in them. In 1854, for example, a young lawyer went from Munich to Darmstadt, where his father resided. Up to that time the father had never lived out of Darmstadt, and Darmstadt was as free from cholera as Hampstead, and the distance from Munich was much greater than Hampstead from Broad Street. The lawyer was as well in health as Mr. Eley had been, but the lawyer's father fell ill and died of cholera. There was no other factor in the case than the return of the son from Munich. Darmstadt enjoyed an immunity from cholera as great as that of Lyons, Versailles, Stuttgart, and many other large cities. In 1854 a workman went home from the Exhibition of Munich to Darmstadt, where he fell ill and died of cholera without the disease being spread to any other house, and no means for disinfection or isolation had been adopted. In 1866 Prussian troops were quartered in Darmstadt, and brought the cholera with them. About thirty of the soldiers became ill with cholera, and many of them succumbed; again, none of the inhabitants of Darmstadt had the disease. It must be admitted that Mrs. Eley might have been infected through the intercommunication of her son, just as the lawyer's father had been, without the intervention of drinking-water. The argument in favor of the drinking-water theory rests on the fact that the cholera ceased when the supply of water was cut off; but no notice was taken of the great majority of cases in which the water-springs were not closed, and the supply of water not cut off, and yet the epidemics came to an end. Again, in Broad Street the pump-handle was not taken off till September 8th. Now, an examination of the facts will show that the cholera was already subsiding. In Broad Street, on August 31st, there were thirty-one cases of cholera; on September 1st, one hundred and thirty-one cases; on the 2d, one hundred and twenty-five; on the 3d, fifty-eight; on the 4th, fifty-two; on the 5th, twenty-six; on the 6th, twenty-eight; on the 7th, twenty-two; and on the 8th, fourteen. Just as occurs in India and elsewhere, a violent epidemic generally subsides rapidly.

The further one investigates the drinking-water theory the more and more improbable does it appear. Robert Koch, too, the famous bacteriologist, has hitherto failed to substantiate the drinking-water theory, and I feel convinced that the time is not far distant when he will own that he has gone in the wrong direction. Koch has succeeded in finding the comma bacillus in a water-tank in a region where cholera was prevalent. I have the greatest respect for this important discovery, not as a solution of the cholera question, but only as a very promising field for pathological, not epidemiological, inquiry. It must be remembered that cholera was already prevalent in the neighborhood of the water-tank from which Koch obtained the bacillus. Now, this tank was used not only for drinking purposes, but also for bathing the person and washing clothes, as Koch himself admits. According to my view the comma bacillus must have been present in the water. It

had not been shown, however, that the bacillus was in the water before the outbreak of cholera. Koch is of opinion that all the bacilli in the water-tank could not have come from the washing of clothes of cholera-patients, but must have partly been derived from multiplication, yet he forgets that, as he himself has shown, the meat-broth in which the bacilli grow must not be too dilute. It would have been interesting if Koch had estimated the strength of the nutritive material in the water-tank. But what chiefly contradicts the doctrines of the contagionists is the simultaneous disappearance of the cholera on land and the cholera bacillus in the water-tank. If it were really true that every case of cholera, the first as well as the last in an epidemic, had the same infective material in its intestinal discharge, and that the epidemic only ceased because the susceptibility of man had passed away, then the bacillus would continue to exist in the tank, always supposing that there was sufficient pabulum for it. And thus it is most probable that the bacillus gets into the tank from man, and not *vice versa*. While Koch was in Calcutta the English physicians there imbued him with their views on cholera and drinking-water. The English had been brought up on the drinking-water theory of typhoid fever and cholera, and could only lay it aside with difficulty. But a few of those English physicians who had studied wide-spread epidemics had renounced their original ideas. Dr. Bryden (the chief of the Statistical Department), Dr. J. M. Cuningham (the sanitary commissioner), Dr. John Macpherson (the Inspector-General of the Bengal Army), Dr. Lewis, and Dr. Douglas Cunningham were all disbelievers in the drinking-water theory. Koch was further strengthened in his views, in opposition to the few Englishmen just named, from the fact that after Fort William in Calcutta was supplied with pure water no more cases of cholera occurred there, although it had formerly been ravaged by the disease. The gentlemen in Calcutta had not, however, told Koch the whole truth. For it was a fact that cholera had begun to decrease in Fort William since 1863, and yet the fresh water-supply was introduced as late as March 25, 1873. Moreover, it was not true that the only improvement then effected was a change in the water-supply, for many other changes were carried out, the fortress being made a model of cleanliness. Alterations in the drainage of the soil were effected in and around the foundations of the building, which before this was nothing more than a morass during the rainy season; so that, inasmuch as the nature of the soil, as well as the drinking-water, was changed, the case of Fort William affords an argument as much in favor of the localists as it does for the contagionists. I may here call to mind an episode which was much commented on at the time, and which is perhaps of the nature of an experiment. Macnamara writes, in his work on cholera: "In connection with this position I may narrate a case which happened in another part of the country, but for which the facts can be vouched. Some dejecta from a case of

cholera found their way into a jug of drinking-water, and the mixture was exposed to the heat of the sun for the day. Early the next morning a small quantity of this water was drunk by nineteen individuals. Nothing was noticed, either in the appearance or taste of the water, by those who had partaken of it. All remained well during the first day. On the following morning one man was seized with cholera as he awoke; the others remained well till the second day had passed, when two more cases of cholera occurred, and the day after that two other cases were observed. The rest of the party remained well till sunset of the third day, when again two were seized with illness. These were the last cases, and the other fourteen persons continued to enjoy immunity from diarrhœa, cholera, or any disturbance of health." This case is, etiologically, not worth much. Where was the original case from which the infection was supposed to have come? Was it not possible for the nineteen persons to be brought under the same circumstances as those under which the original case had become affected? Were the nineteen in a place which was as a rule free from cholera, and could they only be affected through the drinking-water? Several cases in India are known to me where guests at a banquet having drunk no water were yet the victims of cholera. For instance, at a baptismal feast which a sergeant gave, a gallon and a half (six litres and three quarters) of rum was supplied. Twelve persons, including the man and his wife, sat down to the banquet, and on the following evening the whole of the group, except the baby which still lives in Calcutta, were in their graves. At this feast there was no question of a mixture of anything with the stools of cholera.

When I ask myself how it is that men usually astute can place such implicit reliance on the drinking-water theory, which entails such ambiguity and contradiction, I can only think of two reasons. Partly, no doubt, there exists the belief that on general hygienic grounds no stone should be left unturned in order to procure a good supply of water where it had previously been bad, and thus the fear of death and the devil proves stronger than the love of truth and God. Again, the drinking-water doctrine appears to many to be the lesser evil as compared with the threatening local and periodical predisposition, which implies a more mysterious and less definable conception. They imagine that the (to them) uncomfortable facts of time and place may be explained on the drinking-water doctrine. The places where the cholera excreta can contaminate the drinking-water have a local disposition, and the times at which even cholera prevails, and excreta may contaminate springs and water-courses, have to do with periodical dispositions, and thus they escape from explaining the subtile influences of soil and ground-water. But any one who thoroughly investigates the local and periodical factors in epidemics of cholera must reject such an explanation. A study of the tables previously given from Brauser places great obstacles in the way of accepting these doctrines.

The constant periodicity of cholera in Calcutta or Madras can not thus be cleared up. In the same way it is impossible to understand on this doctrine how it is that the hot, dry season, which must be destructive to the bacilli, is the period during which cholera is most prevalent, and how it is that in the hot and wet season, which is favorable to the growth of bacilli, cholera is at its lowest ebb. That cholera and typhoid fever are more flourishing when the ground-water is sinking than when it is rising has been explained by the drinking-water theorists on the view that when the ground-water is falling it becomes more concentrated, thicker, and therefore more dangerous. Now, the prolonged researches of Wagner, Aubry, and Port have proved the direct opposite. When the ground-water is low it is always purer than when high. Dr. Port has studied for a number of years the state of the water in the garrisons of Munich, with a view of watching its relations with the movement of typhoid fever, and he has found that when the water began to be impure then a falling off in the disease might be predicted. Why this should be so has received an experimental explanation from Dr. Franz Hoffmann. Great and numerous are the objections to the explanation of the local disposition to cholera by means of the drinking-water doctrine. Lyons was until the year 1858 supplied with water from superficial wells. The analyses of the waters from a number of the wells prior to the introduction of a better supply would astonish any one. The contagionists get out of their difficulties by merely asserting that though it is always the water which transmits cholera, yet there are a thousand ways in which this may be accomplished. But we have already shown that severe epidemics may occur without drinking-water being implicated, and consequently it is questionable whether, in those epidemics where the water may have been a factor, other causes did not play a more important part in the development of the malady. It is for the contagionists to prove why the infection by drinking-water can only be verified in certain cases. The most popular argument of the contagionists is the proposition that cholera spreads by human intercourse, a fact which I unhesitatingly accept. But the interpretation which the contagionists put upon the fact is nullified by the fact itself, as is shown by a closer study of all the influences of intercommunication, whether by land or sea.

In many regions there are main streets running in watered valleys in the direction of the stream, and yet other principal streets having a direction at right angles to that of the stream. In these streets, as is well known, at short intervals there exist sites which may be dotted on a special map where the frequency of cholera may be investigated, just as I had done for the epidemic of 1854 in Bavaria. It transpired that the sites of the epidemic preferred to spread in the length of those streets in the valleys which followed the course of the stream. When, however, one investigated the epidemic spots in streets which cross valleys between which hills or table-lands lie, it was found that

the cholera attacks those sites which lie in a valley which crosses the streets, and the places which are situate on the heights between two valleys are spared. In the valleys, however, which are only crossed by one principal road, the epidemic spreads itself in places which lie in the valley upward and downward in the direction of the river, although the intercommunication may be very slight and the river not navigable. In Central India for a long time the great rivers were the principal means of communication, and the cholera spread by preference along these routes. When in recent times the Indian railways were started, it was thought that cholera would forsake the old routes and travel along the railway. But such was found by Cornish not to be the case. Of course, the same statement holds good in Europe. Saxony is perhaps as thickly peopled and as much overrun with railways as any state in Germany. Since 1836 cholera prevailed in Saxony on no less than eleven different years; but, as Reinhard and Günther have proved, its propagation was not in any way directed by the developing net-work of railways. Certain places in Saxony always were the centers for cholera, and so remained despite the railways. Freiberg, in Saxony, was never visited by cholera either before or after the railway was completed, while certain parts of the Mulde and Pleisse Thal were regularly visited. As often as an epidemic of cholera broke out in North or South Germany, cases were observed in Saxony; but for an epidemic to develop in Saxony always required time. Every year in Saxony which was marked by a heavy death-rate from cholera was preceded by a year during which the mortality was comparatively slight. Thus, in 1849 there were 488 deaths; in 1850, 1,551; in 1865, 358; and in 1866, as many as 6,731; again, only four cases in 1872, but 365 in 1873.

If the cholera can be brought by sufferers direct from India to Toulon, where the sea-passage lasts only three weeks, then if the disease prevail in North Germany it must always spread to South and West Germany, and inversely, since we have nothing but cholera on the one hand and healthy people on the other. But whoever studies the history of cholera will find nothing but contradictions of this postulate of the contagionists. In 1854 Berlin took no cholera from Munich, and in 1866 Munich received no cholera from Berlin, notwithstanding extensive intercommunication during the Industrial Exhibition and despite the war.

A PROJECT IN INDUSTRIAL EDUCATION.

By FRANKLIN HAVEN NORTH.

THE "children of the public," as the street Arabs are called by that agreeable writer, Edward Everett Hale, are known for their acuteness rather than for their docility. The *mots* of the Paris *gamin* give to the French *feuilleton* not a little of its spice, and his Anglo-Saxon pro-

totype, though more subdued, is no less ready at repartee. Each gives evidence of an acute mind and a keen perception. But playing in the street, vending the public prints, running of errands, and like employments, do little to instruct or elevate, and, though by no means barring the door to more praiseworthy and remunerative vocations, are so beset with allurements as to dissuade the average youngster from entering. Reared in the street, he is accustomed to excitement, and, as he grows up, discovers neither aptitude for trade nor inclination for any other occupation. In the city of New York are thousands of these street-urchins : some live in the street from choice, while others are driven thither ; some go to the public schools, some to the reformatories in lieu ; while others, again, add variety to their existence by devoting a part of the year to the one and a part to the other. But public schools, excellent as they are in New York, could scarcely be expected to succeed in teaching those not inclined to learn ; and there are those who assert that reformatories do not reform, and hence it is that the lad who has spent the allotted time in the process of being schooled and reformed, often starts active life too young for manual labor, and too ignorant and unskilled for the work of the artisan. As a result, those are led into a career of crime or indolence whose instincts, under more favorable conditions, would have inclined them in the contrary direction, and whose latent abilities gave more than ordinary promise. Having once tasted the pleasures of untrammeled existence, they evince impatience under restraint and cold indifference to persuasion, and have, therefore, come to be looked upon as incorrigibles, and beyond the reach of charitable effort.

Dissenting from the prevailing opinion as to these lads, a number of New York business-men, having succeeded in other fields scarcely more promising, determined to see for themselves if kindly treatment and careful instruction would not serve to wean them, or some of them, from the street, and encourage them to employ their energies to better purpose. Led by Felix Adler, whose theories on this subject they had come to adopt, they established, some seven years ago, what is called the Workingman's School.

They sought to base their system upon common-sense principles, in which the manual labor of the artisan and the mental work of the scholar should go hand in hand, and both be rendered attractive. It was, too, a theory with these men, that the children of the poorest, even those of the professional mendicant, could be made, with intelligent treatment and instruction, the equals of their fellows reared amid more fortunate surroundings ; and from the inception of the enterprise down to the present time they have eagerly sought out those children who, from appearance and situation, might not unreasonably be looked upon as the least promising subjects for instruction. How well they have succeeded it is not the purpose of this paper to decide. It will be sought simply to lay before the reader a general synopsis of

the plan of the school and of its practical working; and, as the system has been in operation nearly eight years with the most gratifying results, it may not, perhaps, be found a difficult task to estimate what effect, if any, such teachings, if generally introduced, are likely to produce in the condition of outcast children.

The system may be said to be original, since it is not founded upon any other known to exist. It is best adapted to a country where republican ideas prevail, and where, as in the United States, the political equality of the whole people is the fundamental principle of government. The underlying principle of the system, and one which it is sought to impress upon the minds of the little workingmen is, that all labor is honorable, and that greater dignity should attach to hand-labor. The managers maintain, and few will be found to dissent from the opinion, that the most effective means of raising the dignity of hand-labor is by improving the condition of the workman; educating him in his calling, making him self-reliant, original, progressive; and to this end they bend all their energies.

It may not at once appear how hand-labor is dignified by making expert artisans of children plucked from the streets. But it should be remembered that in this country there is no class distinction: men may rise as far as their abilities will take them; the lowest in origin may aspire to the loftiest position, with none to ask them whence they came.

Unlike the industrial school, no age is fixed upon for entrance into the Workingman's School. That period of a child's life at which it breaks things in order to see what makes them go has been selected as the best time to begin to instruct its mind and direct its hands. In the industrial school certain trades are taught; youth is forced to look upon the stern realities of life, the coming struggle for bread, and to fix upon particular vocations ere yet the natural preferences are sufficiently developed to enable it to do so. When the course is completed, there is no time to change; the daily bread must be won, and thus it not unfrequently happens that he who would, perhaps, have been successful as a decorator, proves but an indifferent carpenter; and one who could easily have earned a competence as a mason is forced to eke out a scanty livelihood as a molder, a locksmith, or perhaps a brass-finisher. In the Workingman's School, though all the principal trades are represented, no effort is made to incline the little workingmen to the one or to the other.

Again, in the public school from which many of these little fellows are deserters, no allowance is made for the grades of intellect or rather for the various conditions of intellectual development. It is a ponderous educational machine, in which a certain amount of raw material being put in at one end will, in a given time, be passed out at the other in a more or less finished condition. The bright subjects, always in the minority, are, no doubt, much benefited; the others, upon

leaving, can have scarcely more than a confused idea of what they are supposed to be proficient in. At given times they have been served with a given quantity of mental nourishment, but, as those seated at table are not always able to partake of the same food in the same quantities at stated periods, so pupils, however endowed by nature, can not always digest new ideas nor investigate new subjects with equal readiness.

The theory of instruction is based upon natural inclination. A child visiting the circus, menagerie, museum, or theatre, is all eyes, all ears. Question it upon its return home, and you will, doubtless, be surprised at the amount and variety of its information. It has seen and heard that which you have failed to see and hear.

It is this faculty of the child of absorbing itself in what pleases or interests it that has been seized upon by the managers. In the public school, the young, restless with the impatience of childhood, are forced to remain quiet while attempts are made to describe to them a something which they have never seen, and, not being based upon anything in which their interests have previously been excited, leaves, at best, but little impression on their minds. When it has begun to dawn upon them that Columbus was a man and not a fish, and that he came hither in a sailing-vessel and not in a steamship; when they are a-hunger and a-thirst for information as to his reasons for believing there was a New World in the West, the bell rings and they are ushered into the awful presence of an arithmetician, who knows all about the denomination of numbers, circulating decimals, and the like, and who, having memorized all the rules, thinks everybody else should be compelled to do the same. This system of opposing the natural inclinations of the young is, perhaps, best expressed in the retort of the lad to his mother when she told him to go to bed early in the evening: "You make me go to bed when I'm not sleepy, and get up when I am!"

An inclination of the visitor to the Workingman's School, as he looks over the heads of the children at work, is to compare their lot to his own when a boy. Unless he was unusually gifted, he will recall the tedious hours he spent while trying to memorize the rules in his grammar—rules which he didn't always understand—the struggle with the coefficients of the *n*th power of binominals, and so on. He will remember with what reluctance he sometimes entered the school-gates and with what satisfaction he often closed them behind him. Holidays were marked with a red letter in his diary, and vacations not infrequently looked upon as the condemned are wont to look upon temporary respites. But now, as he looks about him, he sees children absolutely interested in their studies and their work. And such work!—molding with moist clay, cutting, sawing, and planing with real tools, fashioning artistic designs, and so on.

The youngsters of his day often absented themselves from school, and stolidly took the punishment which such dereliction entailed, in

order to witness work of this nature at a neighboring manufactory or workshop. Now, he beholds a school which is a workshop in itself; where the boys, instead of having to content themselves with looking on, are permitted to take an active part. He sees whole classes of children interested in arithmetic, algebra, and geometry, and listening to talks upon geographical and historical subjects with evident relish. In his day the allurements of geography were by no means so strong as those of foot-ball; and he never could get himself to look upon mathematics with that ardor of affection which he was wont to bestow on mumble-the-peg.

By what arts, it may be asked, do the teachers at this particular school succeed in suddenly awakening the interest of children in subjects which heretofore have not particularly attracted them? By making them interesting instead of tiresome. How many children will be attracted by the statement that Africa is the division of the world which is the most interesting, and about which the least is known; or that Afrigah, from which its name is supposed to be derived, is said to mean "colony" in the ancient Phœnician, and, having been given by the founders of Carthage to their territory, is supposed to have spread to the whole continent?

But children are ever ready for stories and the relation of exciting adventures, and through this faculty, it has been found, they may be led on from one event to another of African history, from one point to another of African topography, till, finally, what heretofore they may be said to have regarded as an unpalatable dose, is successfully administered in the form of a sugar-coated pill.

Instead of beginning at the commencement of African history, at least at the point where our knowledge begins, and gradually working forward through all the dry details, the contrary course would be pursued at the Workingman's School. The children would be told about Stanley and how he found Livingstone. This would naturally lead to Livingstone, and to why Stanley went in search of him. Then would follow the mission that brought Livingstone to Africa; the Nile, and the various conjectures regarding its source, and the reason of the world's impatience to know it; the Niger, and the interesting story of the finding of its course by Richard Lander, after his master had failed in a similar attempt. Egypt and the Suez Canal would be gradually worked in, as well as the history of the Continent of Africa and its relative position on the earth's surface.

By such a course, it has been found, connected ideas are given of geographical points and historical incidents and eras. The mention of ancient Greece to one so instructed would mean something more than a portion of land included in the most easterly of the three peninsulas in the south of Europe, and which, beginning at latitude 40° north, is bounded by a chain of mountains extending from the Thermaic Gulf on the east, and terminating with the Acroceraunian promontory on

the Adriatic in the west. It would bring to his mind a connected chain of events.

In teaching algebra, geometry, and trigonometry, objects are used as much as possible. Thus, in the latter, the reason why the angles are not employed as in geometry, but in their stead certain of their functions are used, is practically demonstrated. Then a system of triangulation might be begun by the scholars, in which a base is measured from a single known point, the latitude and longitude of which are computed, and the azimuth-compass brought into play to find the true direction of the line. From this base, other triangles and finally quadrilaterals might be laid off and computed as well as the curvature of the earth, which is traversed and comprehended by the scheme of triangulation. The amount and variety of the information which the young are capable of receiving when their interests are excited would surprise those who, perhaps, have had neither the time nor the inclination to observe them.

The little workingmen are instructed in decorating, molding, turning, the work of the forge, carpentry, and are made to take an active part in experiments in mechanics, hydrostatics, hydraulics, sound, heat, light, electricity, and magnetism. They are retained in the school until they thoroughly comprehend their work and studies.

The children who fill this great building from top to bottom look to be those of well-to-do people, for their clothing is tidy, their faces clean, and their eyes bright. Such, however, is not the case. The school-workshop is recruited from districts the most squalid, from abodes the most humble. No origin is so low, no intellect so dull, that it may not demand and receive admittance within these hospitable, catholic walls.

In the eyes of many this will, perhaps, be looked upon as the most commendable feature of the institution.

Those whom curiosity or other motive has led into the by-ways and the somber courts that mark the abiding-places of the very poor laboring-man have often recorded their conviction that here is the best, though perhaps the most difficult, field for philanthropic work.

The difficulties that stand in the way of such an enterprise as the Workingman's School are sufficient to dissuade the ordinary enthusiast in such projects. They can best be understood by those who are sufficiently interested to inquire into the whole scope of the undertaking. Children, especially those of the poor, are often very hungry early in the day, and to attempt to instruct or even amuse them under such circumstances is alike idle and illogical. Again, poor children frequently lack proper clothing to protect them from inclement weather. All this has been foreseen by the managers. A midday meal is provided for the children, and clothing when required is distributed with no niggard hand.

As might be expected, children are continually being received into the school who are unclean and accustomed to uncleanly habits. These are washed and taught to keep themselves clean. Those come, too, into whose young lives no spark of happiness has ever entered, who are sad and do not smile, and it requires no little skill to induce them to forget their childish woes, and take part in the games and occupations of their comrades.

But it is in dealing with character in its various phases that the managers would seem to have scored the most marked success.

There are those who, like Henry George, believe that humanity is much the same; that a cruel instinct may be traced to a childhood which no spark of kindly solicitude ever served to brighten, and sullenness and obstinacy to a novitiate of injustice and ill-treatment. Others there are who insist that, as the father, so is the child, and these may be set down as agreeing with Hesiod, who distributed mankind into three orders: The first, he says, belongs to him who can by his own powers discern what is right and fit, and penetrate to the remoter motives of action; the second belongs to him that is willing to hear instruction and can perceive right and wrong when they are shown him by another; but he who has neither acuteness nor docility, who can neither find the way by himself, nor will be led by others, is a wretch without use or value.

"If any one denies," says Herbert Spencer, "that children bear likenesses to their progenitors in character and capacity, if he holds that those whose parents and grandparents were habitual criminals, have tendencies as good as those whose parents and grandparents were industrious and upright, he may consistently hold that it matters not from what families in a society the successive generations descend. He may think it just as well if the most active, and capable, and prudent, and conscientious people die without issue, while many children are left by the reckless and dishonest. But whoever does not espouse so insane a proposition must admit that social arrangements which retard the multiplication of the mentally-best and facilitate the multiplication of the mentally-worst must be extremely injurious."

Now, with no desire to affirm the proposition of the one, nor to point out the fallacy of the other, let us see what has been the experience of the managers of the Workingman's School in this regard; let us see how much heredity of temperament and inclination has there been exhibited by juvenile humanity while under treatment.

As may readily be seen, if only the promising children could be permitted to enjoy the benefits of the school, and the vicious and stupid children were excluded, the work of the projectors, if it did not fail utterly, would, at least, be greatly restricted in its scope, and wanting in that particular attribute whence the most important results were looked for.

It is, perhaps, not immediately obvious how it can affect a scheme

by which it is sought to train a certain number of poor children, if the vicious be excluded. But the theory of the founders of the institution is that children are not naturally vicious, but are rendered so by surroundings or influence; and hence, if they failed in successfully dealing with them, they would be compelled to fall back upon the assertion that bright and well-behaved children may be made into expert artisans —a proposition which no one has ever denied.

Fortunately for them and fortunately for those whom they especially set out to aid, not one child out of that multitude which has applied for admission has been found to be beyond the reach of intelligent treatment; not one has been found where evil propensities were more than skin-deep.

Strange to say, the lad who upon entry proved the most stupid, most stubborn, and ill-mannered, rose by rapid stages until, finally, he reached the head of his class! This lad, upon his first appearance, was found to be not only dirty and ragged, but so obstinate that he would only answer questions when it pleased him to do so. His eyes were half closed, he rarely looked up, and altogether he seemed, if the description of those who saw him may be relied upon, more fitted for the career of a cow-boy or that of a bandit than for such peaceful occupations as those of the mechanic and decorator. The manager of the school called up the official physician and asked him what ailed the lad. The physician made a careful examination, and then reported that, besides being naturally vicious, the lad was weak-minded. But this was by no means satisfactory to the manager. He examined the lad himself, and made an altogether different diagnosis of the case. In his opinion the lad's behavior and appearance were due to a long course of ill-treatment and neglect. He had him thoroughly washed, fed, and clothed, and prescribed good treatment.

At first he was dull, very dull; his mind seemed never to have been called into action, but little by little he began to wake up; day by day his eyes opened wider and wider; the cloud that seemed to have settled over his face was gradually dispelled; and finally one day, when something more interesting than usual was afoot, he so far forgot himself as to smile. Henceforward he gave no further trouble. His teachers say he made rapid progress, and they finally discovered that, instead of being mentally weak, as the physician had said, he possessed a mind unusually acute.

Many of the children when first entered exhibit that viciousness which, it is alleged, is inherent in those whose parents are of a class essentially vicious. These children, or many of them, may be said to have been reared in the gutters, and they found even the gutters more agreeable than the darkened, squalid chambers provided for them in the adjoining tenement-house, and willingly risked the dangers of the crowded street without rather than endure the ill-treatment to be had within. At first they show a disposition to repel the advances of

those who would do them a service, as if, unaccustomed to kindly treatment, they felt these advances only concealed new projects for their discomfiture. A supply of new clothes and a few comfortable and palatable meals do much, it has been found, to dispel this feeling, and the round of interesting tasks set before them, in which the hands as well as the mind are called into action, has a still more powerful effect in awakening the better instincts of childhood.

The experience of the Workingman's School tends to verify the conclusion of an eminent writer, that the theorem relative to the moral and intellectual debasement of societies would, when pushed too far, have consequences even more inadmissible than that relative to their physical debasement, and that the principle of mental and moral debasement is by no means so much to be relied upon as the law of physical heredity.

This conclusion has not been reached by a course of reasoning but by actual observation, and though, of course, it does not go far enough to be conclusive, furnishes, nevertheless, valuable data; data which may yet do much toward refuting, at least in part, the arguments which have from time to time been put forward by learned reasoners.

The children of what might be called professional mendicants have shown, when their intellects were polished up and dusted off, as we might say, not a whit less intelligence nor more uncanny characteristics than their fellows; the children of intelligent workingmen; and he would be a bold man who, after observing the present condition of these children, should predict that, when cast loose with an artisan's education, both practical and theoretical, they will fall back upon the charitable institutions instead of earning their own bread and butter; and he would be no less bold who should prophesy an ultimate career of crime for those children who were gathered, while very young, from the haunts of the criminal and the outcast.

This is no scheme of indiscriminate charity in which those who are the most importunate get the most relief, nor is it an institution where the children of the well-to-do may get an artisan's education gratis. There always has been plenty of encouragement for the workers in the great human hive, but here is a project to stimulate those who might not unreasonably be expected, on account of their surroundings, to be the drones and the criminals of the future, into honest activity, and enable them to obtain by their own industry more wealth or comfort than could be hoped for in a career of crime or indolence.

THE PAINLESS EXTINCTION OF LIFE.*

By BENJAMIN WARD RICHARDSON, M. D., F. R. S.

DURING the latter part of 1883 and the early part of 1884, I constructed at the Dogs' Home, Battersea, at the request of the committee of that institution, a lethal chamber for the painless extinction of the life of the animals which have, of necessity, to be destroyed there. I put the process first into operation on Monday, May 15th, by subjecting thirty-eight dogs to the fatal narcotic vapor. They all passed quickly into sleep, and from sleep into death. Since that time, for a period of seven months, the lethal chamber has been regularly in use. From two hundred to two hundred and fifty dogs per week have been painlessly killed in it, or a total of nearly seven thousand.

The thought of applying the anæsthetic method to the painless destruction of the lives of the lower animals, and the first accomplishment of it, came from myself, and dates back as far as the year 1850. In that year, I constructed at Mortlake, where I was then starting in practice, a small lethal chamber, to which my neighbors would frequently bring animals which they wished to have killed. In 1854 I began to illustrate this mode of painless death, and from that time up to 1871 I never allowed the subject to rest. In 1871 I brought it formally before the Medical Society of London. About this same time I made a communication to the Royal Society for the Prevention of Cruelty to Animals, and suggested a mode for killing painlessly dogs and cats that were wounded in the streets. From that time I have continued the inquiry, making use of all the known anæsthetic substances, in order to ascertain which was cheapest, most adaptable, most certain in action. The information thus obtained proved very useful when the time came for utilizing it.

In undertaking the practical act of carrying out lethal death on the large scale required at the Home, I had to determine, in the first place, on the anæsthetic or anæsthetics to be used; and, in the second place, to construct the room or chamber in which the animals should be confined while exposed to the lethal gas or vapor. I have placed on the wall a table of anæsthetics, including most that have up to this time been discovered, with a general outline of their respective properties and values. There is, you see, a goodly list, twenty-two in all. Out of these I selected, as shown by experiment to be the best, four : Carbonic oxide, chloroform, carbon bisulphide, coal-gas.

Carbonic Oxide.—I was led to carbonic oxide, not only by reading of it, and by witnessing the effects of it as a poison when it has been breathed from coke-fumes, but specially from studying its action when

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TABLE OF ANÆSTHETIC GASES AND VAPORS.

NAME OF SUBSTANCE.	Elementary composition.	Material condition.	Gas or vapor density H = 1.	Fluid density, water = 1.	Boiling-point. Cent.	Boiling-point. Fahr.	PHYSICAL QUALITIES.
					Deg.	Deg.	
Nitrous oxide	NO	Gas	22	....	..	..	Supports common combustion; sweet. and not irritating to breathe.
Carbonic oxide	CO	Gas	14	....	..	..	Burns in oxygen; not irritating to breathe.
Carbonic acid	CO_2	Gas	22	....	..	..	Extinguishes flame; irritating to breathe.
Bisulphide of carbon	CS_2	Fluid	38	1·270	43	107	Vapor burns; odor disagreeable unless well purified.
Hydride of methyl (marsh gas)	CH^3H	Gas	8	....	..	..	Burns in air; inodorous, not irritating.
Methylic ether	C^2H^6O	Gas	23	....	..	..	Burns in air; almost inodorous when pure.
Methylic ethyl ether	C^3H^8O	Fluid	30	....	11	52	Burns in air; ethereal odor; rather pungent.
Chloride of methyl	CH^3Cl	Gas	25·25	....	..	..	Burns in air; rather pungent.
Bichloride of methylene	CH^2Cl^2	Fluid	42·5	1·320	40	104	Vapor burns; pungent odor.
Chloroform	$CHCl^3$	Fluid	59·75	1·480	61	142	Vapor extinguishes flame; pungent odor.
Tetrachloride of carbon	CCl^4	Fluid	77	1·560	78	172	Vapor extinguishes flame; odor fragrant, not pungent.
Hydride of ethyl	C^2H^6H	Gas	15	....	..	..	Burns in air; inodorous.
Ethylic ether (absolute ether)	$C^4H^{10}O$	Fluid	37	·720	34	93	Burns in air; pungent to breathe.
Chloride of ethyl	C^2H^5Cl	Fluid	32·25	·921	11	52	Burns in air; ethereal odor; rather pungent.
Ethylene (olefiant gas)	C^2H^4	Gas	14	....	..	..	Burns in air; pleasant to breathe.
Bichloride of ethylene (Dutch liquid)	$C^2H^4Cl^2$	Fluid	49·5	1·247	80	176	Vapor burns; ethereal odor; rather pungent; smoky.
Chlor-ethylidene	$C^2H^4Cl^2$	Fluid	49·5	1·174	64	147	Vapor burns; ethereal sweet odor; pungent.
Bromide of ethyl (hydrobomic ether)	$C^2H^5B^2$	Fluid	54	1·400	40	104	Vapor rather pungent, but pleasant.
Hydride of amyl	$C^5H^{11}H$	Fluid	36	·625	30	86	Vapor burns in air; inodorous when pure.
Amylene	C^2H^{10}	Fluid	35	....	39	102	Vapor burns in air; pungent; smoky.
Hydrocyanic acid	HCN	Fluid	..	·705	26	70	Vapor painful to breathe; special; suffocating odor.
Coal-gas	....	....	..	....	..	..	Gas at first slightly irritating, but quickly narcotic.

evolved from the fumes of the *Lycoperdon giganteum*, or common puff-ball. The fumes as thus evolved have been employed for centuries past by the common people for narcotizing bees before taking the honey from the hive. A portion of the substance being burned under the hive, the bees, inhaling the fumes, fall into a deep sleep, during which time they are unconsciously deprived of their industrious earnings. I was so struck with the perfect action of these fumes after being shown one of these experiments, that, in 1854, I introduced the fumes for anæsthetic purposes. Purified by being passed through water, they produced the most rapid narcotism, under which many operations were performed painlessly on the inferior animals. The question was the character and chemical nature of the agent in the fumes which produced the anæsthesia. The late Dr. John Snow, so well known for his immense labors on anæsthetics, and the late Mr. Thornton Herepath, one of our most promising chemists, were each separately engaged in discovering the concealed gas or vapor. Snow and Herepath simultaneously, but by quite different methods of research, arrived at the fact that the narcotic present was carbonic oxide,

or the same gas as is produced during the combustion of carbon or coke in a limited supply of oxygen.

These researches led me to study the action of this gas in its pure form, and to the discovery of many curious facts relating to it. Among other things, I noticed that, like oxygen, it made the venous blood of a bright-red color, and that warm-blooded animals exposed to it for a long period of narcotion are rendered temporarily diabetic.

I did not, on the whole, think it commendably safe as an anæsthetic for man, but I fixed upon it at once as one of the best and cheapest of lethal agents for the painless destruction of life in the lower creation. It is the principal agent for this purpose which I have used since the date named above, 1854.

Carbonic oxide is a gas, and, if quite pure, is so odorless and produces so little irritation that, when present in the air, it is apt to be breathed unconsciously until the effects of it are felt. Those who by accident have been narcotized by it, and have recovered from the effects, have expressed that they had no recollection of anything whatever, that they passed into sleep in the ordinary way of sleeping, and knew no more.

Chloroform.—I was naturally led to chloroform, by reason of its common use as an anæsthetic. There is no anæsthetic more certain in its action, and none more certain to kill if it be administered in a determinate manner. Administered even with skill, so as not to kill, it proves accidentally fatal about once in twenty-five hundred times, and, so soon as air is charged with over five per cent of its vapor, it is not breathed without danger. Death from it is very determinate when it occurs, and seems to be entirely painless. The vapor of chloroform does not burn ; on the contrary, it extinguishes flame. If we plunge a lighted taper into a jar through which the vapor of chloroform has been diffused, the light is at once extinguished. When we use it for narcotism, we merely diffuse the fluid into the state of vapor, and make provision for the vapor to be absorbed by the lungs of those subjected to it. It produces little irritation when breathed.

Bisulphide of Carbon.—The bisulphide of carbon is a very rapidly-acting anæsthetic. It produces narcotism, in fact, almost as quickly as carbonic oxide, and with less muscular commotion. The vapor of it burns in air if a light be brought near to it ; but, when its vapor is mixed with that of chloroform, this danger is avoided. It is bought as chloroform is, in the fluid state, and can be obtained, therefore, from the chemist directly, ready for use, by diffusion of its vapor. It has one immense advantage, that of being excessively cheap ; and it has one great disadvantage, that of being excessively unpleasant in regard to its odor, unless it be most carefully purified by repeated distillations. Combined with chloroform, with which it mixes freely, the peculiar odor is largely reduced, and, by pouring the mixture over chloride of lime, is almost entirely removed. For this reason, together

with that relating to the difficulty of combustion of the combined vapors, I have used largely in these researches the mixture of chloroform and carbon bisulphide. The combined vapors produce also a singularly good antiseptic atmosphere.

Coal-Gas.—Common coal-gas is one of the most potent of narcotizing gases. It is a compound of four gases, three of which are excellent narcotics, and one a negative gas—forty-seven per cent of hydrogen, forty-two of marsh-gas, three of heavy hydrocarbons, and eight of carbonic oxide. All these gases are anæsthetic in their action: marsh-gas is one of the best, and carbonic oxide is one of the quickest; but they are all explosive.

For the lethal purpose, nothing could possibly surpass coal-gas. I put it freely to the test, and found it was all that we could desire. In an atmosphere containing twenty-five per cent of this gas, an animal goes to sleep in from two to three minutes, and dies asleep as easily as in any narcotic vapor or gas whatever. The gas is always at hand, and for the present purpose is the cheapest and readiest of all. Under such circumstances, it seems absurd to think of going any further for a narcotic agent. And yet it is necessary, at all events, when a large lethal chamber is wanted, on account of the danger from explosion. All things considered, I was led to conclude that carbonic oxide was the best narcotic agent to employ, combining it with chloroform or carbon bisulphide, if that should prove necessary. Deciding on this point, the next question was how to manufacture the carbonic oxide so as to bring it into practical use on the easiest as well as the largest scale.

After making some unsatisfactory experiments, I luckily recalled Mr. Clark's condensing-stove. This is a most ingenious invention. The fumes proceeding from the combustion in the furnace first ascend and then descend through two lateral columns, to escape by a tube directed over a trough or saucer. A large quantity of water-vapor is in this way condensed, and is collected at the base of the stove, together with substances derived from the combustion, which are soluble in water. Here, with a little modification, was what I wanted. To adapt the stove to my purpose, I got Mr. Clark to make a charcoal furnace over a gas-burner, so that, when the charcoal was laid in the furnace, it could be instantly set alight by merely turning on and lighting the gas, letting the flames of gas play through the charcoal. Next I got him to make a large condensing cistern beneath the stove, with an opening from it to convey the carbonic oxide by a tube into the lethal chamber, and with a tap, by which the condensed fluid could be drawn off. The arrangement answered straight away, if I may so say. The immediate combustion of the charcoal by the gas yielded very nearly the theoretical value of the product, carbonic oxide. The gas was deprived of water by the condensation; it was delivered over to the chamber with a steadiness sufficient for all practical necessities;

it was cooled without any other artificial means, so as never to raise the chamber above summer heat; it was produced cheaply; and it afforded such simple action that any workman could at once learn to use it. Another useful result springing from the employment of this stove was, that it enabled me to diffuse other narcotics into the chamber, by merely allowing the warm gas proceeding from the stove to pass over a porous surface, charged with the narcotics, on its way into the chamber.

To apply the narcotic gas or vapor, it is necessary to have a closed place in which the animals are exposed to the narcotic, and another place in which they are collected preparatory to being subjected to the narcotism. This implies what I have called the lethal chamber, and a cage. At Battersea, it was necessary to have an apparatus large enough to narcotize as many as one hundred dogs at a time. It was, therefore, essential to have a large lethal chamber, and one that was strong and effectively constructed. I noted down at the beginning the following requirements, all of which I had calculated out of a series of preliminary studies, and constructed on a small working scale.

1. The chamber, of whatever substance built, must be so constructed that its interior shall not be subject to great variations of temperature. This I knew to be very important, since, in observing the action of narcotic vapors on the human subject, I had learned that humidity and cold materially interfere with their quick action, while dryness and warmth favor such action. In a lethal receptacle, such as was being constructed, there could be no certainty whatever, unless the temperature and dryness were at all times uniform.

2. It was necessary so to construct the chamber that sufficient but not an excess of room should be allowed in it for the expansion of the gases introduced. It might seem at first sight, and before inquiry was instituted, that the more the space within the chamber was reduced the quicker would be the effect. This, however, is not practically the fact. In order to secure perfect diffusion of the narcotic atmosphere, the space to be filled with it must be about one eighth greater than is absolutely required for a cage, fully charged with the animals that have to be killed.

3. Much care is required in connecting the stove with the chamber, so as to make sure of equal diffusion of the gases or vapors through the inclosed space. Unless this equal diffusion is rendered effective, some of the animals are more exposed to the vapors than others, and the effects are irregular, which is as bad a result as could possibly be obtained.

4. It was essential to provide that a sufficient quantity of the narcotic should be introduced before and for a brief period after the introduction of the animals.

5. It was requisite to invent a plan by which the chamber could be kept completely closed until the precise moment when the animals

have to be introduced, then instantly opened for the introduction, and as instantly closed after the introduction. It was equally requisite to guard the entrance into the chamber, so that the men employed in pushing in the cage should be protected from the vapor. A method had also to be adopted by which it could be known when all the animals had ceased to breathe.

To meet the first of the above-named conditions, I constructed the lethal chamber (the outline of which is shown in Fig. 1) of well-seasoned timber, making every part of it a double wall, and filling the interspace closely with sawdust.

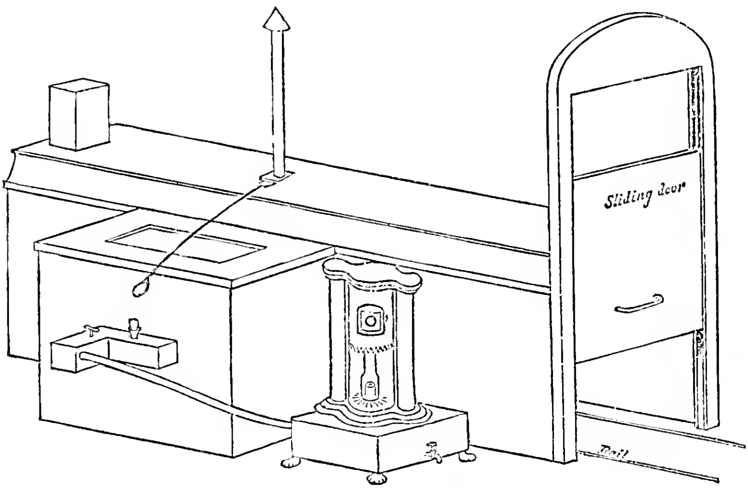


Fig. 1.—The Lethal Chamber.

In order to obtain the slight excess of space which was wanted to insure diffusion, I formed on each side of the chamber an extra space, which I call a pocket. They are in the center on each side, and stand out as aisles from a central nave.

In order to secure quick and equal distribution of the vapors through the chamber from the stove, I let the gases in at first from the top, under the impression that the gases, being heavier than the atmosphere, would be made to pass with greater rapidity into all parts. Theoretically, this view is correct; but, as it became necessary to have two floors or tiers to the cage, I was obliged, in the end, to let in the gas half-way down the sides of the chamber. By using two stoves, one on each side, this method of introduction was both convenient and effective. To remove the common air, an opening, with a shaft of ten feet, was made in the roof. The shaft has a bore of three inches, and has a cap at the top, in order to prevent down-currents of air. At the foot of the shaft is a damper, which can be opened and closed at pleasure.

To meet the fourth necessity, a plentiful supply of the narcotizing vapor, two stoves have been connected with the chamber, each capable of burning two pounds of charcoal per hour, and giving up the products of the combustion into the chamber.

To make the narcotic effect still more certain, and to keep the chamber at all times lethal, I made an extra provision. At the two points where the tubes from the stoves enter the chamber, I have interposed two strong boxes made of elm, and covered with thin lead. These boxes, which are eighteen inches long and four inches broad, are filled loosely with the porous burned loam known as Verity's patent gas-fuel, an excellent substance for filling a grate where coal-gas is burned instead of fuel. This substance is so porous, it takes up narcotic fluids most readily, holds them in its pores, and gives them up in volumes of vapors when warm gas is passed over it. Into the boxes closed in with this fuel there is a funnel, opening at the top, for supplying the fluid, which can be shut with a stopper; and at the end of the box, standing out at a right angle from it, is a continuous section, in which there is a large tap, for regulating the currents of gas from the stove.

When the stoves are in action, the tap is turned on, and the gases from the stove pass through the boxes over the patent fuel into the chamber. Nothing more is done until just before the time when the animals in the cage are to be introduced. Then ten fluid ounces of an anæsthetic mixture, consisting of equal parts of methylated chloroform and carbon bisulphide, are poured upon the fuel through the openings in the top of the little boxes, the openings being immediately closed. After the animals are in the chamber, ten ounces more of the same mixture are added, and if, after three or four minutes, any of the narcotized animals are still breathing, ten or twenty fluid ounces more are poured in.

In pushing the charged cage into the chamber, there is naturally a very great displacement of gas or vapor within. It was necessary to provide an exit which would save strain on the walls of the chamber, and would let out a little gas without letting in common air. I met the problem by the plan shown in Fig. 2, which exhibits the chamber in section. Two feet from the far end of the chamber there is suspended from the top a light hanging screen, which reaches within four inches of the floor. Behind this screen, and in the roof of the chamber, is a shaft, with a valve opening upward. As the cage is pushed in, this screen is raised from the bottom, and the air, rushing out at the lower part, ascends behind, and escapes by the valve. The screen is so balanced that, when sufficient air has been extruded, its lower end reaches the back or lower end-wall of the chamber. It thus acts as a regulating valve, and, when the pressure is off, it returns to its level, letting any gas at the rear of it return toward the cage.

To enable the operators to introduce the cage quickly, and at the

same time to protect them from the action of the vapors, the following plan, also indicated in the section diagram, is adopted. The door or entrance into the lethal chamber is a slide like the sash of a window. It is placed between two strong uprights, and is balanced by a weight and pulley in each, so that it can be opened and closed with the greatest rapidity. Behind this sliding door there is placed what I call the

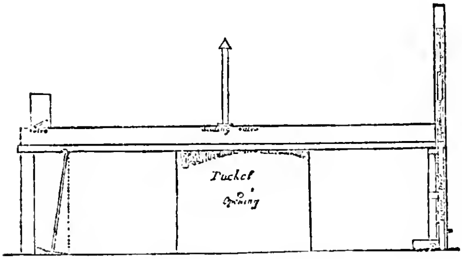


Fig. 2.—Reduced Section of Fig. 1.

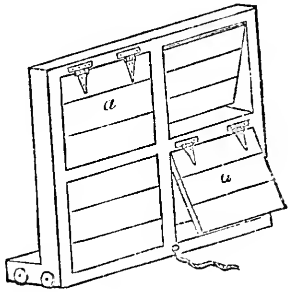


Fig. 3.

shield or block; a framework of wood with four large metal valves, two opening inward, two outward. The shield is fixed on a base with four little wheels, and runs easily up or down the chamber. When the sliding door is raised, the movable valved shield is in position half a foot within the chamber, and cuts off all escape of vapor. The workmen thus have time to push the cage leisurely, after the door is raised, into the chamber, until the end of the cage touches the screen. This effected, they push the cage in a few seconds into the lethal atmosphere, the shield running before it, and then the door is slided down into its place. When all is nicely adapted, a very few seconds are required to introduce the cage and close the sliding or entrance door. When the cage is drawn out the shield is drawn out with it, by means of a cord which is attached to it, and which runs under the cage.

The last requirement which had to be met was the means of knowing when the narcotized animals had ceased to breathe. To get at this fact, the test of hearing was found to be the best. There is inserted into the chamber on one side a long stethoscope, made of bamboo; the mouth of this tube—of trumpet-shape—is in the center of the chamber, just above the cage, when that is in place. The outer part, or ear-piece, of the tube stands out four inches on the outside, and is closed when not being used, by a solid plug. On listening through this tube, the continued breathing of even a single animal can be detected, and the operators are enabled to determine if it be proper to increase the strength of the narcotic atmosphere, or to stop it.

In Fig. 4 will be seen best a description of the cage in which the animals are collected before being put into the lethal chamber. It is made of a wooden framework, with light iron side-bars. It has two sliding doors at the sides, two at one end, and one at the top. It can

be filled and emptied through these doors with great rapidity. In order to hold as many animals as possible without discomfort to them, the cage is divided into two divisions or tiers, the flooring of the upper tier being freely perforated with openings, so as to establish a com-

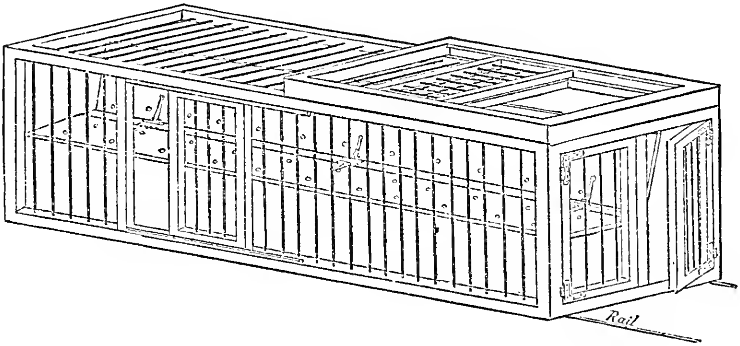


Fig. 4.—The Cage.

munication between the upper and lower divisions, and allow a due distribution of the gases and vapors used. The cage runs on four eight-inch wheels, which are underneath it, and ply on galvanized iron rails.

The mode of death to which the animals are subject is that by anæsthesia, not by suffocation or asphyxia. Physiologically, there is a distinctive difference between these modes of death. Death by anæsthesia is death by sleep; death by asphyxia is death by deprivation of air. Death by anæsthesia is typically represented in death by chloroform; death by asphyxia is typically represented in drowning, or in immersion in carbonic-acid gas. When properly carried out, death by anæsthesia is by far the most certain and least violent of the two processes, although both are probably painless. It is worthy of record, however, that all animals are not equally susceptible to the action of the narcotic vapors. Cats, for instance, lie asleep much longer than dogs before they cease to breathe. They fall into sleep as rapidly as dogs, but do not pass so quickly into the final sleep. There is a difference between different animals of the same kind. Some dogs die almost instantly—in fact, as they fall asleep; others fall asleep and continue to sleep for several minutes before they cease to live. In the first observations, before I had rendered the narcotic atmosphere overpoweringly active for all cases, there were a few instances, nine in the first seven hundred, in which the animals slept on from half an hour until an hour after all their comrades had died. Finding out this strange peculiarity, I increased the amount of narcotic vapor until all succumbed very nearly at the same minute, and in the last six thousand there has been no recurrence of the prolonged insensibility. The animals are now commonly all asleep in from two to three

minutes, and have ceased to exist in a further period of the same duration.

In Fig. 5 there is shown a view of the portable lethal chamber ready for use. It takes the shape of a closed truck on two wheels, and movable like a truck or barrow. It measures five feet in length, is two feet wide, and two feet six inches high. It moves very easily,

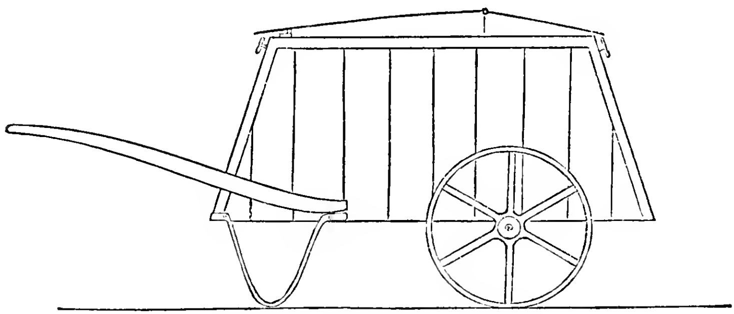


Fig. 5.—Portable Lethal Chamber.

and can be managed by one man. It is constructed, like the large lethal chamber, of well-seasoned wood, in double wall, with sawdust filling up the interspace. In Fig. 6 the apparatus is shown in section. There is one large chamber, having a capacity of nine cubic feet. The chamber opens at the top by a strong lid, swung from behind, which,

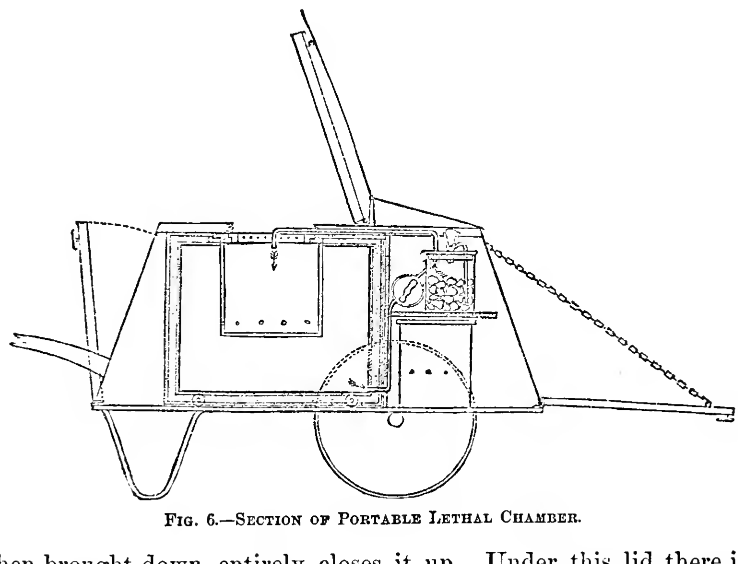


Fig. 6.—Section of Portable Lethal Chamber.

when brought down, entirely closes it up. Under this lid there is a frame with an opening in the center, through which baskets or cages of different sizes, and containing the animal or animals, can be let

down into the larger space and held there. This larger space is the narcotizing receptacle or chamber.

At the back of the apparatus is a recess in which are placed the narcotizing fluid and the pump for forcing it into the cages containing the animals. The narcotic fluid is contained in a large, strong Wolff's bottle filled loosely with Verity's fuel. The forcing-pump is worked by a piston from the outside, and consists of a cylinder capable of containing one eighth of a cubic foot of air or gas. From the farther end of the cylinder are two tubes, one of which runs into the narcotizing chamber at the lower part, the other to the long tube in the Wolff's bottle below the surface of the narcotic fluid within the bottle. From the short or escape tube from the bottle is a continuous tube, terminating over the cage containing the animal. By an extra tap coal-gas can, if desired, be let into this chamber.

The animal to be slept into death is placed, resting on a little straw or hay, in a cage, which is then dropped into the large receptacle, the lid of which is at once closed. The handle of the piston is then moved up and down at a regular and quiet pace. As the piston is drawn out, the cylinder of the pump is filled with air from the large receptacle, and, as the piston is pushed back, it forces the air with which the cylinder has been filled through the narcotic fluid, a portion of which it raises into vapor and forces into the cage. Eight strokes of the piston charge one cubic foot of air with the narcotic vapor to saturation, and, as there are only nine cubic feet in all to charge, a couple of minutes are sufficient to charge throughout.

The animals in this apparatus pass quickly into sleep, and die not quite so quickly, but quite as painlessly, as in the larger structure.

This smaller apparatus will be so complete when it is finished that it may be wheeled from the station to a private house, if that be wanted ; or it may be used in the streets for giving painless death to wounded animals. It may also, in future, be constructed at so comparatively trifling a cost that I see no reason why every town in the country may not be in possession of one, and every small animal be spirited away in sleep. Compared with other modes of extinguishing animal life—such as hanging, drowning, poisoning by prussic acid, shooting, stunning—the lethal method stands far ahead on every ground of practical readiness, certainty, humanity.

By means of carbonic oxide, sheep can be put to sleep with the greatest rapidity before they are slaughtered. I have submitted forty sheep in this way to painless death, and found that no bad effect whatever is produced in the flesh unfitting it for food. The objection to retention of blood, so strongly felt by the Jewish people, does not obtain, the animals in the narcotic state yielding up blood just as freely as in the ordinary way, when no narcotic is used. The same process is equally applicable to swine, calves, and fowls. To oxen I do not as yet see its immediate application.

It is believed that the larger apparatus could be constructed now for from £150 to £175, and the smaller for £50.

The cost of charcoal for the stoves with the addition of anæsthetic fluid is, in the large chamber, a little over one halfpenny per animal when eighty to a hundred are killed at one time. When fewer are killed the expense is a little increased; the trouble and substance required being as little for a hundred as for a less part of that number.

FISH AND FISHING IN CHINESE WATERS.

By M. MAURICE JAMETEL.

THE Yellow Sea is distinguished above all other things by the abundance of the life it sustains, both on its surface and in its depths. Everywhere that there is enough water to carry them, in the numerous rivers and canals, and on the coast-waters of China, there are coming and going constantly boats of every shape and size, in fleets. The activity of this marine life is owing not more to the comfort with which the abundance of water-surface and the frequency of harbors allow it to be kept up than to the intense vitality and fruitfulness of the denizens of the water itself. Wherever there is a little water, organized beings increase and multiply so rapidly that the most industrious labors of the fishermen impose no check upon them, and measures to protect them would be superfluous.

Once, as I was crossing the marshes between Tientsin and Peking, I noticed here and there little ponds of water that had been left by the melting of the ice in the spring. I should have given them no attention if I had not observed some peasants wading through them, as if they took pleasure in the occupation. I asked my driver what they were doing, and he said they were catching fish. Hardly believing him, I went up to one of the ponds, and found two men engaged there, one scooping up little fish with a hand-net, and filling a basket with them, and the other catching with his hands frogs to keep company with the fishes; and this in a puddle which a European tadpole would have hardly deigned to live in.

The great abundance of ichthyic life in the Chinese waters is frequently ascribed to the high development which pisciculture has attained in the Celestial Empire. I should say, from what I have observed, that it is due to the wise pisciculture of the past, under which a reserve of aquatic life has been accumulated, so abundant that years of improvidence and waste have not been sufficient perceptibly to reduce it; for the art of pisciculture, like some other arts which once flourished in China, and are now in decay, has of late years fallen into comparative disuse.

With oysters the case is different, and the Chinese are still obliged to keep up a systematic cultivation. At Ta-kao, in Formosa, two methods of propagation are employed. The first consists in casting here and there on the mud-banks, stones, which are to be taken up again five or six months afterward, when they will be found to be covered with oysters. The other method, called by the natives bamboo-culture, is more complicated, but also more productive. In August or September the oystermen prepare a number of bamboo sticks, of about the size of a walking-cane, by pointing one end and splitting the other end to about half-way down. They wedge a flat oyster-shell into the cleft, and, bringing the splits together at the top, insert them to be held into a hole they have bored in another oyster-shell. They then plant the stakes, in close rows, where they will be covered at high-tide, so that the fry can attach themselves to them. As soon as the little oysters have formed on the sticks, the latter are transplanted to the mud-bank, whence they are pulled out, in time, covered with oysters large enough to eat. The Chinese pretend that the fry forms on the oyster-shell, and can be preserved there indefinitely. All the pains we have described are taken to promote the hatching of the eggs with which the old shells are supposed to be already covered.

The Chinese aquatic fauna is exceedingly varied, and contains representatives of nearly all the kinds that are found in the waters of Western Europe. The fishermen have given to each species a particular name, which is generally suggested by its form, or by some other distinctive characteristic. Thus, they have the war-god crab, so called because its head looks like the head of that divinity ; the little bonze crab ; and the all-sour crab, so named from its bad taste. The scientific disciples of Confucius have adopted these names in their more or less fantastic works on the natural history of the Middle Kingdom, and the painters have enriched these works with illustrations intended to facilitate the understanding of the text. Frequently the pictures, notwithstanding their imperfections, give a more exact idea of their subjects than the pretended descriptions by which they are accompanied. The last are, in fact, so fanciful that it is impossible to form a conception of the creatures to which they are supposed to relate. Thus, we may learn from them that frogs have only three feet, while lobsters are provided "with so great a number that the most patient man can not count them." The accounts of the habits of the creatures are even more fabulous than those concerning their structure. Some are said to live without eating ; some to increase by breaking into pieces ; and others to be able to live as well on the land as in the water.

Authenticated by the signatures of the disciples of Confucius, and by appearing in print, these fables are believed by the people more readily than even the observations they may make on the animals themselves The fanciful descriptions of three-legged frogs, made by a *literatus* who lived three hundred years ago, is to-day accepted by

all the Chinese who pride themselves on being in the least degree familiar with the classics. Thus, in spite of the protestations of the poor frogs, who gambol in their best style on the banks of the ponds to show everybody that they are planted on four feet, the Mongolian painters and sculptors, regarding the writings of the *literati* as oracles, persist in representing them with only three feet! But the painters, even the most violent partisans of the romantic school, do not allow themselves to amputate a limb except when dealing with a purely artistic work. For common scientific books, they do not give themselves the trouble to put on a surgeon's apron for so little, and it is on account of this indolence that the plates that adorn the works on natural history are more true to the representation of nature than the text they illustrate.

I was so fortunate as to find one day, in a curiosity-shop in Canton, an old album in which were represented, in fifty-two brightly-colored plates, the principal fishes of the southern littoral of the Celestial Empire, which I have studied with much interest. I can not undertake to describe all the plates here, but will limit myself to the accounts of the species which would be regarded with most attention by the inhabitants of the West.

One of them is a singular animal, shaped somewhat like a whale, but with a head so like a woman's that we have to believe that the artist, rather than Nature, has been indulging in a little fancy-work. The accompanying text informs us that it is a shark of the species "three women with a long tail" (*à longue queue des trois femmes*). It is one of the most remarkable of the numerous sharks of the Yellow Sea. The Chinese pretend that its head resembles a woman's, whence its name; then, they ascribe to it the power of the evil-eye, but only under particular circumstances. Thus, if they take a three-women shark in their nets, they think it a bad sign, and throw it back into the water to ward off the evil spirits. But, if they take one of these same sharks with a hook, they regard it as a good sign, and the poor animal pays with his life for the happy message he brings the ungrateful fisherman. Another plate represents a shark of the kind called bird-eaters. The animal derives its name from a fondness for winged flesh, which is in singular contrast with the habitual voracity of its congeners. In seeking to gratify its taste it lies upon the water as if dead. The sea-birds, taken by the trick, settle down upon what they think is a carcass out of which they can make a feast. When a sufficient number of them to give him a good taste have gathered upon his belly, Master Shark begins to sink his body slowly into the water, commencing with his tail, so as to drive his victims up to his head, and within reach of his capacious mouth. The whole operation, including the swallowing, is performed with such facility that we have to admire it at the expense of our sympathy for the victims of it.

The sharks play an important part in the life of the Chinese people, both of the coast and of the interior. The Yellow Sea is infested by

the numerous species, and has acquired a dreadful celebrity among the fishing and sailing population. In return, they pursue it with great ardor, and, thanks to its greediness in biting at all kinds of bait, with much success. The meat is eaten with relish, but the cartilaginous fins being much sought for by epicures, are too dear to be within the reach of the common people, and appear, along with bird's-nest soups and trepangs, only on the tables of the rich. The trepang, or holothuria, the third favorite viand of the Celestials, along with its concomitants, the sharks' fins and the bird's-nest soups, bears a very high price. Hardly any amount, even up to its weight in gold, is considered too great to pay for this exquisite dish, which, besides its delicate taste, is supposed to have the precious quality of assuring to those who eat it a numerous posterity. The animal, so great is the demand for it, is now rarely found in the Yellow Sea, but those which are consumed in the restaurants of Peking and Canton are brought from Australia and the Marianne Islands, and this fact goes to enhance their price. The holothuria-fishery is, moreover, a very difficult one. The animals live upon the rocks at considerable depths. The fishing is carried on by Malays, who go out in April or May in little boats, providing themselves with long rods armed at the end with a sharp hook that fills the office of a harpoon and a dredge. When the sharp-eyed fisherman discovers a trepang in the depths, he takes his rod and with a dexterous stroke sweeps the animal from the rock and lands it in the boat. The trepang-catchers are, however, much aided by the marvelous clearness and smoothness of the water in the regions where their game is found.

Chinese fishing-nets are made precisely like those used in the West, preferably of hemp; but, in very large nets, the silk of a wild silk-worm is used, to make them lighter and more manageable, as cotton is used by the Dutch fishermen. Before casting a new net into the sea, it is dyed a suitable color. For this purpose, it is dipped into a solution of mangrove-bark, to preserve it from rotting, and is then colored with hog's blood. The new net is then spread upon the beach; candles are lit, and tapers of paper and incense are burned about it, to secure the blessing of the Queen of Heaven. If the net is of cotton, maceration in oil takes the place of the dipping in the solution of mangrove-bark. The harpoons and the hooks are of iron, the lines of hemp, straw, and bamboo-fiber; and the boat-sails are also generally made of straw or bamboo-fiber, as Western canvases are still beyond the means of the fishermen.

Six kinds of boats are used, according to the nature of the fishery in which they are to be employed, the largest of which, the *ta-tsang*, requires a crew of six men. It is fifty or sixty feet long, and, like all the Chinese junks, is flat-bottomed, with square bow and stern. The rudder is rigged in a similar manner to those of our lighters, but is bored with round holes which let the water through and augment its

action on the ship. It is also capable of being moved up and down, so as to increase or diminish the extent of the submerged surface. In some junks, it can be let down below the bottom of the vessel, and this property permits the craft to be handled very rapidly, and within spaces in which our otherwise better ships can not turn. The *ta-tsang* is divided into close compartments, each of which has its particular use; and has two masts, one in the center and the other toward the stern, each carrying a square bamboo-leaf sail. The sails are furled by letting down the upper yard, but are difficult to manage in bad weather, on account of their large size; so that, when at sea, it is deemed prudent to carry only half-sail. These boats are within the reach only of the aristocrats of the sea. The boats of the common fishermen are much smaller and more manageable. The most curious among them is the one which is called the "white jump." It is a long shallop, drawing but little water, and furnished on one side with a broad board painted white, which is fixed so as to slope toward the water. The boats only go out in clear moonlight nights, when the light reflected from the white surface attracts the fish, and they try to leap upon the plank. But they usually leap too far and fall into the boat.

With their nets, hooks, harpoons, and "white jumps," the fishermen of Swatow and Ningpo capture so many victims that there would be danger of their being killed to no purpose, had not Chinese industry found a way to transport them for long distances, to where they may make regal repasts for epicurean mandarins. The fishermen of Ningpo preserve their catches in ice, which they manage, notwithstanding the mildness of the climate, to get made on the spot. The Chinese processes for making ice are servile imitations of those of Nature. The rice-fields are the factories. When the cold begins to be felt, the flats are covered, by the aid of pumps, with a very thin bed of water. The ice which forms during the night is broken up every morning by coolies, who carry it, carefully cleaned from adhering mud, to the ice-houses, and then flood the fields again. The ice-houses are simple in construction, but capacious; for the climate of Ningpo is too mild to permit ice to be formed every year, and the proprietors are required by law to store in them enough to last three years. The ice-house consists of a vast quadrilateral, inclosed in walls made of stones cemented with mud, rising some twenty or twenty-five feet above the ground. The faces of the walls are thickly plastered, and the whole is then covered with heavy bamboo-matting, which is supported by a framework also of bamboo. The ice-houses of the north are smaller and less solidly constructed, for thick ice forms there abundantly every winter, and is more easily kept through the summer. In the vicinity of the capital, the ditch which anciently inclosed its domain is still well enough preserved in some places to serve as an ice-pond, and the ice-houses are built near its banks.

The fishermen also require large quantities of salt, and this is

manufactured in a very simple manner by the primitive method of the solar evaporation of sea-water. The salt-factory consists of a large terrace, above which is another terrace of only one sixth the superficial area of the lower one, and of two salt-water cisterns, one at a short distance from the terraces, and the other between them. The terraces having been covered with a bed of gravel, the larger or lower one is filled with water, which is admitted at high tide through a sluice-gate in the dike. After giving a sufficient time for the soil of the terrace to absorb the water, the gravel, on which a considerable quantity of salt has accumulated, is raked up. At a little above the level of one of the cisterns is fixed a filter made of bamboo rods. On this is piled the salted gravel which has been collected from the lower terrace, and through the whole is run a stream of sea-water from the larger cistern. The water, having absorbed the salt from the gravel over the filter, is then led into the smaller cistern—the one between the terraces—and from this is taken and spread over the second terrace, where the solar heat soon removes it by evaporation from the dissolved salt. The salt is then ready for use without any further preparation. Two men are sufficient to work a salt-bed that will furnish an average of seven hundred and twenty kilogrammes of salt every two days—a return that would be extremely profitable were it not for the taxes. But the manufacture of salt is a government monopoly, and whoever goes into the business has to pay the state seven tenths of all that he produces ; so that the road to wealth, for the individual, is not, after all, through a salt-marsh.

Busy as he is at his busy time, the Chinese fisherman's life is a hand-to-mouth existence, and it is a great strain upon him to maintain himself through his dull season. Men of this craft have then to resort to other side-trades to eke out their living. Some of them gather up shells on the beach and burn them into lime ; some split off the nacreous parts from large muscle-shells and carve them into square semi-transparent panes, which serve as substitutes for window-glass ; and others, going to the oyster-beds, skillfully pry open the shells so as not to disturb the inhabitants, and slip into them pieces of wood carved into fanciful shapes, which will in time become thinly covered with nacre and be sold for mother-of-pearl ornaments.

In view of the precarious condition of their existence, the fishermen have formed themselves into societies for common protection against the rapacity of the mandarins and to give assistance to such as may be in need. The society at Haï-Meun constitutes a strong corporation, and possesses a large building, where its business meetings are regularly held and theatrical representations are given ; a hall for the public weighing of such fish as are sold by weight ; and a temple where sacrifices are made before going to sea, with a space in front of it in which the new nets are spread for the performance of the ceremonies of consecration.

Mr. J. Duncan Campbell, of the Chinese Marine Customs in London, said in an address, in 1881, that "without any acquaintance with the laws of capital and labor, the Chinese fishermen have come to a practical solution, satisfactory to all of them, of the question of coöperation in benefits." This agrees with my own conclusions, and is accurately true of the large masses of fishermen living around Swatow. These fishermen are formed into labor-unions, which are important according to the scale of fishing in which they are engaged. The most considerable companies are those which employ the *kaio-kou*. Each of them controls two large junks (*kaio-kou*) having crews of fifteen men each, and forty-five shallops carrying usually three men each; making in all forty-seven boats and one hundred and sixty-five men. Each company is directed by a chief, who has under his orders a steward to keep the accounts and attend to the sales. The systems for dividing the proceeds are different in different places and with different companies. In one of the companies each 10,000 francs is divided as follows: 1,800 francs for the hire of the boats and the fishing-implements, which are let by a capitalist; 250 for the expense of religious sacrifices; 300 for the salaries of men under employ who do not belong to the company; 400 for the helmsman; of the remaining 7,200 francs, half to the captain, and the rest equally among the men of the company. In the smaller companies, which usually employ only shallops, the proceeds are commonly divided into fifteen parts, six of which go to the captain, two to each of the four men of the crew, and one is applied to the sacrifices. Some companies give thirty per cent to the capitalist who furnishes the ship, seven per cent to the chief of the company, four per cent to his steward, seven per cent to each of the junks, and one per cent to each shallop. The boats divide their shares into as many parts as there are men in the crew, *plus* one, and that goes to the helmsman, who always has two parts.

The river-fisheries are not so lucrative as those of the sea, and less generally give employment to a class of professional fishermen. The tackles used in carrying them on are not essentially different from those employed in similar kinds of fishing in Europe. In the more important river-fisheries, however, two auxiliaries are employed that are wholly unknown in Western fishing—the otter and the cormorant. The otter, which is frequently met in the Blue River, is trained to drive the fish into the nets, and does it as dexterously as the best hunting-dogs bring the coveys within reach of their masters' fowling-pieces.

The cormorant does all the work of fishing for his master, who only has to take care of the boat. The birds stand upon the edge of the shallop till the boatman gives the signal, when they spring into the water to perform their task. As soon as they have captured a large fish or filled their throat with smaller ones, they return to the boat and their master takes possession of the prey. If they find a fish too

large for one bird to take care of it alone, two or three of them will join to assist in bringing it in.

The cormorants are trained for their business with great care. The most intelligent birds are said to come from the province of Che-Kiang. The eggs of the first spring laying, which usually takes place in February, are collected and put under hens, the maternal love of the cormorant being only feebly developed. The young when first hatched, being extremely weak and delicate, and prone to succumb at the slightest chill, are put into wadded baskets, where they can be kept at a uniform temperature. They are fed with pellets of beans and finely chopped eel, till at the end of a month, when, having become nearly covered with feathers, they are given the eel alone; at the end of another month, they are able to eat small fish whole, and are worth five dollars a pair. When they have got their growth, which is about five months after they are hatched, they are tethered by a string tied around the foot on the banks of a stream or a pond. The trainer, stirring the water with a pole, and whistling an air which the birds learn is the signal for "take to the water," throws in some small fish, which they attack with all the more voracity as they have not been too well fed. The trainer then whistles another air, which is to be the signal for coming back, and, that the birds may not be mistaken as to its meaning, he pulls at the same time upon the cord that holds them. These lessons are continued for two or three months, when the scene of the practice is changed to the boats; and at the end of another month the cord is dispensed with. There are, of course, differences in the capacity of cormorants as well as of men. While the stupid ones are sent to the pot, the most sagacious and best trained male birds are worth seven or eight dollars apiece, females less. The period of service of the cormorants is short. They begin to lose their feathers and to go into decrepitude in their fourth year, and generally die before they are six years old. Whether this brevity of life is due to the peculiar style of feeding the birds, or is one of the inevitable attendants of domesticity, is not known; for we have no authentic information respecting the length of life of cormorants in a wild state.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE ACCURATE MEASUREMENT OF TIME.

BY THEO. B. WILLSON.

THERE are few people who have much knowledge of the present state of the science of measuring time. This is probably owing to the scarcity of sources of information on the subject, for almost every one has more or less interest in it. One might naturally suppose that his jeweler could discourse intelligently, if not profoundly,

on such matters; but he is a very exceptional man if he has any considerable knowledge of the principles underlying the construction of the most common chronometers, so far as they employ principles not found in common clocks. In illustration of this ignorance of the subject, even among workmen who are thoroughly competent to treat all the disorders of time-pieces properly, and that to the degree of constructing broken or missing parts, or of mending fractures so nicely as to leave no trace of a break, the following instances may be given:

The clock most commonly used by the watch-makers as a "regulator" is one with what is called a "gridiron" pendulum. This consists of nine brass and steel rods, side by side, with their couplings so arranged that, in the changes of temperature, the variation of the brass counteracts that of the steel. Now, it is the fact that a large per cent of these pendulums are simply false "gridirons," while a very small per cent of the watch-makers are able to tell the difference. One might suppose that the running of the clock would reveal this at once. But it should be remembered that the variations of a clock on account of temperature are very slight. An abrupt change of ten degrees maintained through twenty-four hours will cause a seconds pendulum to vary but a little over two seconds. Bearing in mind, then, that a pendulum may be timed to a mean temperature, and that thus the variations would tend to equalize each other; that, if the clock should thus come within a second a day, it would satisfy most watch-makers; and that as a matter of fact they ordinarily do change their "regulators" several times a year—we have little difficulty in accounting for the wide-spread ignorance of theory among them. To this may be added the consideration that there is no money in knowing about these things, and that to know about them takes time that might become money.

Again, we shall find our jeweler almost equally ignorant of the principles of compensation in the balances of watches. There are but few of them, indeed, who can not tell the genuine balance from the spurious, but there are hundreds of them who could not state, if life depended upon it, why the brass must needs be on the outside and the steel inside in such a balance, or why the converse arrangement would not be equally good, or whether the screws in the rim have anything to do with the compensation.

If, then, those who might be expected to know know so little, where shall we look for information? In view of the general ignorance of this matter and interest in it, a plain and untechnical account of the difficulties in the way of measuring time accurately with clocks or watches, and the progress that has been made in obviating them, may be profitable.

The whole matter of the accurate measurement of time turns, of necessity, on the manner of controlling the rate of escape of the mechanism which indicates the time. Thus far there are only two

devices which have been found to do this with anything like accuracy, the pendulum and the balance-wheel. Postponing, for the present, the discussion of the balance-wheel, we have before us the pendulum.

That the pendulum might be used for the measurement of time is a discovery which dates back, at least, to the time of Galileo. A great many, even among well-educated people, suppose that that philosopher discovered that a pendulum of a given length will always oscillate in the same time. This he could not have discovered, for it is not true. The correct statement of the law he discovered is, that a pendulum will always oscillate in the same time through equal arcs, but not through any arc. It has been found that if the curve in which a pendulum swings were a portion of a cycloid instead of a circle, and the pendulum were simple, that is, consisting of a bob or ball suspended by means of a thread imagined to have no weight, its oscillations would be in equal times through any arc. To accomplish this, clocks were at one time made with pendulums which were suspended between cycloidal cheeks, and were thus conformed, in swinging, to the cycloidal curve. But this was soon abandoned, as it was found that it was impossible to construct such cheeks without variation or imperfection sufficient to make a greater error in the pendulum than it would have if allowed to swing on a circular arc. For a short distance the cycloidal curve corresponds quite closely to the circle. Therefore, by adjusting the pendulum to swing but a short distance, it was found to be possible to secure substantial uniformity. This is the plan now universally adopted.

If the arc of vibration is increased, the clock will lose time. Experience with the common house-clock would seem to contradict this, for every one has noted that when the clock is first wound it will gain time, and then that it will lose as it runs down, and, seemingly, this is due to the difference in the swing of the pendulum. The explanation, however, is to be found in the fact that in case the pendulum swings farther it is shortened by the curving of the spring by which it is suspended, and also by an effect which the longer swing is found to have upon the escapement, quickening its time. Any ordinary house-clock would keep far better time if the weight of its bob were considerably increased, as this would do much toward equalizing its swing. Ordinarily the weight of the bob is about three ounces ; if the clock is properly put in beat it will carry a bob weighing as many pounds, and all spring-clocks would be greatly improved as time-keepers by such a change. If this is true, some one may ask, Why is it not made by the manufacturers? The answer is, that any firm who should put such clocks on the market, superior time-keepers as they would really be, would soon find themselves getting the reputation of making a clock that would not run, and all because the public generally would not have the skill or the patience to adjust the beat properly. Let a servant, for example, take such a clock to her room

at night, with the alarm set to call her up to get the family's breakfast. She sets the clock on an uneven table, and in a short time it will stop, and the girl will not be alarmed in the morning, except on discovering that the clock has stopped, and that she has far overslept herself. Thus, to make a sure clock, the manufacturers must make a poor one. For the best running of a fine clock it has been found that about twenty-seven pounds is the most satisfactory weight for the bob.

If it were not for what may be designated as meteorological changes, the problem of the accurate measurement of time would be solved if we had a heavy pendulum driven uniformly over a small arc. But here are two "ifs." We will take the second of them first, as it is more easily disposed of. Postulating at the outset machinery in the train very nicely executed, and with jeweled bearings so that it will act uniformly, or with the least possible variation, we have before us the question of propelling it uniformly. That the best power for a clock is a weight, is beyond dispute. The invention of the coil-spring came near annihilating the race of good common clocks. "Grandfather's clock," with its wooden wheels and other crudities, is still the superior of the grandson's clock as a time-keeper, for "grandfather's clock" had the great advantage of a uniform power sufficient and just sufficient to propel the clock when it was properly cleaned and oiled. The grandson's clock has a coiled-spring as a motive-power, having, when it is tightly wound, not less than three times the amount of power required to drive the clock, and diminishing in amount, thereby altering the rate of the clock, with each successive hour. The grandson's clock will march on, oiled or unoiled (and therefore usually unoiled), until it comes to a premature end as complete as that of the "one-hoss shay." The "grandfather's clock," on the other hand, which declined to go unless its rations of oil were doled out to it once in a year or less by the peripatetic tinker, is good for another century, since its bearings have been saved from cutting themselves away from lack of oil. The kitchen-clock of to-day can only be made to keep respectable time by so regulating it that the gain it makes when tightly wound shall be offset by the loss as it runs down. Something is gained in spring-clocks by resorting to the fusee—a device which maintains the power of the spring as it unwinds by giving it a greater leverage. This device was much employed by the makers during the early days of spring-clocks; but it was found to be so difficult a matter to secure a chain or cord for the connection that was reliable that the plan has been almost, if not altogether, abandoned. About the only opportunity of seeing a fusee to-day is in an English watch. It has been abandoned by watch-makers in America and in Europe, outside of England, so that the modern watch has no chain, and is made to go uniformly by adjusting to "isochronism," as it is called, which will be explained later.

Assuming that the power for an accurate clock must be a weight, we are ready to pass to the application of this power to the propelling of the pendulum, save this one consideration, that, unless there is some special provision, the clock will not advance while it is in process of winding. This provision is made in fine clocks by means of what is termed a retaining-click—an ingenious contrivance which brings the power of a small spring to bear while the key withdraws the power of the weight. This device is also found in the English—that is, the fusee-watch. Other watches need no such contrivance, for, as one end of the spring is fast upon the winding-post and the other upon the outside of the barrel, winding tends rather to stimulate and not to stop its going. The same is true of marine clocks. But common pendulum-clocks have the outer end of the spring attached to the frame of the clock, and hence the application of the key takes off the power, and the scape-wheel does not advance while the clock is in process of winding.

Supposing ourselves now possessed with a uniform power, uniformly applied to the scape-wheel, the problem arises as to the mode of communicating the power of the scape-wheel to the pendulum, in such a way as to sustain its beat, but not affect the time of it. Without going minutely into the discussion of the escapement, it may be remarked that there are two current forms of it. One of them is termed the "recoil" escapement, and its peculiarity is that it at no time arrests wholly the power of the scape-wheel—that is, it recoils by its own action after a tooth has passed one side of the verge, and returns toward the other beat. This is the escapement of the common kitchen-clock, and the chief objection to it is that, according to no definite law, the swing of the pendulum is made more rapid when the power of the spring is increased, as by winding.

A better escapement by far, and the one used in fine clocks, is the "dead" escapement, of which the characteristic is that, after it makes one beat, the pallet must be thrown off by the return of the pendulum before the scape-wheel can again apply its power. An example of this may be found in the ordinary marine clocks as well as in most watches, in which the lever is at rest after the balance has been thrown in one direction, until the return of the balance again trips it, and then its power is applied in the opposite direction.

This is found to be a satisfactory escapement for fine clocks which are not to be disturbed by any outside influences, but, for tower-clocks, which are affected by the wind, still another form is employed called the "gravity," or "remontoire" escapement, the principle of which is that the power of the clock merely lifts a small weight which is then unlocked by the swing of the pendulum and falls upon it, applying the uniform amount of its weight to propel the pendulum. There are, of course, two such small weights lifted alternately at each beat of the pendulum. The pendulum, therefore, has nothing to do with the

scape-wheel except to unlock it. Absolute uniformity can be secured by this device, as the variations of the clock's power are not felt by the pendulum.

We come naturally now to the problem of maintaining an invariable length of the pendulum in spite of atmospheric changes. There is no substance known which does not expand in the case of a rise in temperature, and *vice versa*. It has been found, however, that white deal wood varies, with the grain, but very little, and hence it is employed in many of the better class of clocks, as being better than a cheap and imperfectly constructed compensating pendulum. Still, this does not give full satisfaction, as other changes, such as that from moist to dry, do affect it in a degree; and hence pendulums have been devised in which the variation of one metal is counteracted by the variation of another in the opposite direction.

The most common form in which we see such pendulums is the so-called "gridiron," which takes advantage of the greater sensitiveness of brass than of steel to changes in temperature. It is made with nine bars of brass and steel alternately arranged, the total length of brass employed being to the steel inversely as the two metals are affected by changes of temperature. It is constructed so that the brass lifts the bob in case of a rise in temperature as much as the steel lets it down. To illustrate the principle of it, imagine a simple pendulum rod of steel; to the bottom of this fix a rod of brass slightly shorter than the steel one, letting it extend upward parallel with it; let a second steel rod now be affixed to the upper end of this brass one, also parallel to the others, and to the lower end of this attach the bob. We have now a gridiron pendulum, but one in which the amount of brass is not sufficient to counteract the changes in the steel. Before it will do this, we must make one more journey up with a brass rod and down with a steel one, affixing on this the bob. To construct such a pendulum it is found necessary to duplicate the first four rods; hence the nine that we always see. The genuine "gridiron" is a pretty good clock, but it is so often spurious that this kind of clock is going out of favor.

A third common device is the mercury pendulum, consisting of one or more cylinders filled with mercury to such depth that the movement of the highly sensitive mercury in the bob will counteract that of the entire rod. This is readily understood by viewing the center of the mercury as the center of oscillation (which it is very nearly), and imagining that the temperature rises. Of course, this center is carried upward half as much as the surface, and so great is the variation in the case of mercury that a vessel of it about six inches deep will counteract the steel rod of a seconds pendulum. This is the pendulum employed for fine astronomical clocks, and all jewelers who can afford them have them for regulators. The only objection to this pendulum is that the mercury, owing to its mass, is not affected by a change of

temperature quite so promptly as the slim rod of the pendulum. But this is not found to be a serious matter.

Of late, zinc has been coming into use in the construction of compensating pendulums. The best tower-clocks now all have zinc pendulums. The principle and the application are the same as in the "gridiron," but the higher sensitiveness of the zinc simplifies the construction to such an extent that, only one return-rod of zinc being called for instead of two, as in the case of the brass, it can be made in the form of concentric tubes, and thus appear as a simple rod.

Such are the principal devices for securing compensation. There are many other ways of reaching the same end, and patents have been issued for ingenious designs, no one of which, however, has come into general use.

But, even with a pendulum compensated with brass, zinc, or mercury, we have not yet conquered the problem of measuring time with great accuracy, for, aside from the practical difficulties of obtaining homogeneous material and getting the proportions of the metals exact, there is yet to be taken into account another cause of variation which one could only be convinced by demonstration is capable of having any appreciable effect. It is that of atmospheric pressure. It has long been known that clocks vary somewhat with the barometer; and, of course, we see that they must, when we remember that a heavier or denser atmosphere tends to decrease the gravity of all objects—to bear them up, as it were—and hence, when the barometric pressure is greater, a clock will run slower. To counteract this, a magnet is resorted to, which is made to approach or withdraw from the pendulum by means of the rise and fall of the barometer. This is placed, of course, below the pendulum, and if nicely adjusted will keep the weight of the pendulum uniform.

If all the above disturbing elements are met by counteracting expedients, we now have a clock which will theoretically run without variation, provided it is once brought into the proper beat. A thumb-screw at the bottom of the bob will accomplish this approximately, but, to do it with the greatest accuracy, it is necessary to have a little cup suspended on the pendulum-rod near its upper end, into which one can drop some small weights, as shot, quickening the variation thereby, since it is a virtual raising of the center of oscillation. Fine astronomical clocks usually have this cup, and the best turret-clocks also.

It is at this point interesting to inquire how closely a clock, constructed in observance of all these principles, can be made to run. Generally speaking, it may be replied that it is a pretty good regulator which can be depended upon for a variation of less than a second a day, through all weathers, despite what is claimed for them by their owners. A distinction must be made between a uniform variation and keeping a mean time. I have a common eight-day spring-clock which does not seem to vary a half-minute in a month. This is, per-

haps, better than many regulators do ; but, while it does not make an average variation of a second a day, it is far enough from making an actual variation of less than a second a day. Something better is obtainable from the very best astronomical clocks, which, indeed, are found to keep a uniform rate, from which they will vary only three or four hundredths of a second daily. But astronomical clocks, as is well known, are not required to indicate the exact time, mean or sidereal, but only to go at a uniform rate, which, if it be found to be practically invariable, is corrected at the time of the observation in which it is employed. The most accurately running large clock in the world, which has been regulated to keep diurnal time, is the Westminster clock in England. When the contract for the building of that clock was given out, it was stipulated that it must come within a second a day. It, in fact, does much better than this, for it is found that its variation is usually less than a second a week. It telegraphs its time daily and automatically to Greenwich, and the astronomer royal has said of it, "The rate of the clock is certain to much less than a second a week."

The other practical method of regulating the escape of a time-piece is through the balance-wheel, which, of course, must be resorted to in case of watches, ship-chronometers, and all clocks which are to be moved or carried about.

The method of regulation now in use in the watch is the result of long study of ingenious men. Starting with the discovery of the balance-wheel, carried back and forth with a diminishing oscillation by means of the hair-spring, we have before us the question of how to unlock the scape-wheel with each swing of the balance. In hunting through all classes of watches which find their way into the jeweler's refuse-box, after having served out their period of usefulness, we shall not be likely to come upon more than three (and certainly not more than four) styles of escapement. The oldest watches in the box will have what is termed the horizontal or barrel escapement. This is the escapement of the so-called "bull's-eye" watch of our grandfathers. These watches always had a great reputation as time-keepers, yet I presume it is safe to say that there never was one in existence which could be relied upon to keep within a minute a day in the pocket, and most of them needed a much larger allowance. This escapement had a small wheel, with its axle parallel with the plates of the movement, and its teeth acted upon the pallets, which were little, flag-like appendages to the staff of the balance, and set at right angles to each other. The chief defect of it was, that a slight variation in the power, acting directly as it did upon the balance, affected very materially the rate of the watch. So that, while our grandfather's clock was even a better time-keeper than clocks of the same grade manufactured to-day, our grandfather's watch is not to be named in comparison with the cheapest modern watches.

The second class of escapements which we shall find exampled in the waste-box is called the cylinder escapement, which still continues to be used in some of the cheaper Swiss movements in boys' watches, and such as the ladies wear suspended from the belt. It is the most compact escapement which has ever been made, and is employed in such very small specimens of the watch kind as are made to be set in the head of a pencil, a shirt-stud, etc. It is by far the most reliable escapement except the lever. Its principle is that the cylinder of the balance-wheel is so cut that each tooth of the scape-wheel must force it partly round to get past it. While it is making this turn, the next tooth of the scape-wheel is caught upon the blank side of the cylinder, and held until the recoil of the hair-spring brings the balance back.

Here and there a specimen is to be found of the old "duplex" escapement to which the modern "Waterbury" is allied. It is so rare as hardly to need our consideration. It is a good escapement when in order, but is rather liable to get out of order.

A third form of escapement, and the one now in use almost universally, is the detached lever. There are patent levers, straight-line levers, and various other levers, but they are all detached levers, for the reason that there is one point, in the course of each swing of the balance, when the lever is entirely free or detached from the balance-wheel, and so stands until the return-swing unlocks it. It is difficult to conceive of anything that would be an improvement upon this, and seemingly no improvement is needed.

Before we pass from the consideration of the escapement to that of the balance itself, a remark should be made as to the relative advantages of different rates of escapement. It is found that up to a certain point what is called the quickness of the train, or, in plain English, the rapidity with which a watch beats, makes a difference with its qualities as a time-keeper. This seems to be owing to the fact that where a watch beats more slowly it is more apt to lose an occasional beat through the jar and tossing about in the pocket. The Swiss manufacturers took the lead, and have for forty years or more made quick-train watches, beating five times to the second, or eighteen thousand times to the hour. The English watches commonly beat four times to the second, or fourteen thousand four hundred to the hour. American watches are made with the quick train of the Swiss, but more commonly with a beat intermediate between the two extremes. It is curious that the English, who have given so much money and thought in the past to the manufacture of time-pieces, do not to-day make a good watch nor a good common clock. Their adherence to the slow train is one of the reasons of their failure in watches, and their retention of the fusee is another. So great has been the decline in the English trade in watches and clocks, that a number of their experts in that line recently recommended petitioning the Government to cause an official investiga-

tion to be made to learn its causes, and what can be done to arrest it and restore the trade.

Perhaps we ought yet to pause, before taking up the balance itself, to take note of a form of escapement employed in chronometers (using the word in its strict sense as applied to clocks which may be moved, but must not be jarred or tossed about, and are to remain in nearly the same position). In this escapement the tooth of the scape-wheel acts directly upon the balance, and after so acting is caught upon a shoulder, from which it is only released by the return of the balance. Better results have been obtained with this than with the detached lever for chronometers, but it is not so good for watches, as it will not bear violent and sudden tossing about into all positions.

To measure time accurately with a balance-wheel, three sources of variation must be overcome—that is, the balance must be adjusted to heat and cold, to position, and to "isochronism," as it is termed—that is, it must in some way counteract its own variation, due to temperature as well as that of the hair-spring; its bearings must be so cut or shaped that changes of position will not occasion unequal friction; it must be made to beat uniformly, in spite of the variations in power which result from doing away with the fusee.

The method of compensating a balance is to-day everywhere the same. A compensated balance consists of a bar of steel, to the opposite ends of which are attached semicircular bows of brass and steel soldered together, the brass outside, and into these bows are screwed what are termed "set-screws." It will be seen that, in case of a change for the warmer, the brass outer rim will expand more than the inner steel one, in each of the arms, and that this will throw the extremities of the arms in toward the center, thus compensating, if the proportions are right, for the general expansion of the balance; and *vice versa* in case of a change for the colder. Of course, it is a very nice piece of experimentation which ascertains these proportions. After the approximate proportions are secured, the exact ones are obtained by means of the screws in the rim. Compensation in a balance-wheel is of far more importance than in a pendulum, for the variation of the rate of the time-piece, if not compensated, is far greater. And this is due not only to the expansion and contraction of the balance, but also to the variation in the power of the hair-spring under various temperatures, as above remarked.

I may pause to note that here is one of the tests of a watch that any one may resort to. There are many imitation compensating balances which look very like the genuine, save that they have not the cut, or have only a notch at the extremity of the bow, so that the bow is not free, and, of course, there is no compensation.

After a watch has been adjusted to heat and cold, it must be adjusted to "position"—that is, so that its rate will not be altered by changes of position. This is a nice piece of work. It is accomplished

by shaping the pivots, blunting them or sharpening, according as it is found to be necessary.

The third difficulty named was that of preventing the different pressures of the mainspring (as when it is tightly wound or nearly run down) from altering the rate of the watch. This is effected in the following manner : It is found to be a fact that there is a point in any hair-spring at which, if it be secured, it will carry the balance-wheel at the same rate no matter what the force of the train. This point can only be discovered by experiment, and the discovery of it constitutes the adjustment of the watch to what is called "isochronism." By continually shifting the point where the hair-spring is pinned, a point is finally discovered where the watch goes at a uniform rate, which may be too fast or too slow, but it is uniform. This point ascertained, the watch is then made to keep diurnal time by shifting the screws in the circumference of the balance.

Of course, it greatly increases the expense of a watch to add these fine touches by the best skilled workmen ; and yet so perfect is the machinery to-day and so closely does the watch when first put together conform to the well-understood proportions that in point of fact a large per cent of them are found to be correct, and need little or no adjusting. In this case they are simply marked "Adjusted," and sent to market. The leading American factories have discontinued the manufacture of watches which have not compensating balances, so that, even though the watch be of cheaper grade, it will still run far better through all weathers than the best watches with a solid balance.

In the American watch we may well take a patriotic pride, for it is the best watch in the world ; and, what is more, it is being imitated everywhere. Its only real rival is the Swiss watch, the better grades of which can hardly be said to be inferior as time-keepers to American watches. The cheaper grades, however, will not rank with the same grades of our watches.

After a watch has been given all the advantages of adjustment described, it is interesting to inquire how closely it will run. But, lest we expect too much, it is important that we keep in mind that a watch is at great disadvantage in comparison with any other time-keeper, for it can depend upon no uniformity either of rest or of motion. No two men's habits of life are such as to give their watches exactly the same jar and disturbance. One man's watch is laid down at night, and another's is hung up ; one man's is in the cold, and another's is where it is warm ; one man is much upon the rail, and another seldom travels at all ; one man's habits of life take him into those sorts of dust which soon clog the oil of his watch, another is never in any dust. Add to all these considerations one more, namely, that a watch will run a little freer, and hence a little faster, when the oil is fresh, and of course will slow down as the oil gets old, and we

have abundant reason for great leniency in judging of the work of these really marvelous machines.

Remembering these things, we shall be prepared to accept the stories about the wonderful running of some watches with more or less allowance. That watches sometimes seem to go with very slight variation for long periods of time is often accounted for by the fact that the accelerating and the retarding effects in the carrying of them have nearly counterbalanced each other. A good watch may be so nicely regulated as to keep a mean time between its variations, which will be very accurate. I have heard of two watches in the course of my life for which their owners claimed that they varied only four seconds a month, and I can not help adding that they sought to touch the regulator just once more to overcome even this variation. With one of these men I had a personal interview, and succeeded in drawing out that, after all, he was not telling what his watch varied, but only how it stood at the end of a month; for aught he knew, it might have ranged a minute or two either way during the time. The other man I never met; but I trust these are the only men in the world who ever imagined that a pocket time-piece can be made to have a uniform variation of less than a second a week. But such men serve as an example of the misfortune it really is if one possesses too good a watch. When a man gets to reading the time on his watch by the second-hand, he is likely to feel discouraged and out of joint with the world much of the time, for his watch will not bear such scrutiny. A far happier man is he who can only afford a poor old "turnip" which, like Sam Weller's, must be set twice a day. A man who possesses one of these wonderful watches, supposed to run to the second, could hardly feel worse to find himself coming down with the cholera than to find that without seeming provocation his watch has gained or lost twenty-five seconds.

I add a few remarks upon the use and care of time-pieces, their visits to the jeweler, etc.

It is to be observed that there are many unscrupulous men working at the bench who have very little real knowledge of their trade, and who, to make a living, must make the most of what they get to do. Such men uniformly declare that any watch which comes into their hands to be repaired needs cleaning, which will cost you from a dollar to a dollar and a half. Sometimes this is true, and sometimes it is not. If you have a stem-winder in a close-fitting case, it is probably not dirty, and yet, if it has run two years or so, it ought to be oiled. This most jewelers will do, if you ask them to, for a small fee. If I owned a fine watch, my practice would be to take it to a jeweler, and have it thus oiled once a year, having it cleaned perhaps once in three.

If a jeweler tells you that there is some very serious trouble or break in your watch, which it is going to cost several dollars to get repaired, ask him to take the watch "down," as he terms it, and let

you see that trouble. An honest man, not overdriven, is always ready to do this.

It is a little better to wind one's watch in the morning than at any other time, since, if you wind at night, and then expose your watch to the cold, the chilling of the mainspring is more apt to break it when tightly wound.

Empty out the dust that accumulates so quickly in your pocket often; it will save your watch from the unnecessary contact and battle with dirt.

It is amusing to hear an ignorant customer betray a fear lest a jeweler shall steal some jewels from his watch while it is in his possession. A friend of mine, who is a jeweler, in such cases always reaches for his bottle in which he keeps his watch-jewels, and asks the customer to hold his hat while he turns them in. This usually brings the customer to his senses. In point of fact, a large part of the jewels in common watches are nothing but glass. Next comes aqua-marine or beryl, then garnet, then ruby, and rarely sapphire. But even a ruby-jeweled watch is a very rare commodity; and even these rarer stones would be of very little value for any other purpose, perforated as they are for the pivot; and the fear lest the jeweler may steal them is simply ludicrous.

There is an amusing superstition, which has not as yet wholly disappeared, that a watch ought not to be turned backward. I hardly need remark that this is wholly groundless, for the "cannon-pinion," as it is called, that carries the minute-hand, is wholly independent of the train, and merely rests upon the prolonged pivot of one of the train-wheels, on which it turns with slight friction; and, indeed, if it should fit too closely, it would be more likely to damage the watch if it were turned forward than backward. The same thing holds in case of a clock, of course, save that, in case of a striking-clock, a backward turn after the "snail" has unlocked the striking-gear, and the clock is about to strike, will cause it to do so, and hence it will strike wrong. And, of course, after it has struck in the ordinary way, it can not be turned back far without the snail's catching on the outside of the lifting-wire. This will make it impossible to turn it back farther. But no turn will in any way injure the clock.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XLVI.—THE COOKERY OF WINE-DRYING.

THE reader will understand, from what has already been stated concerning the origin of the difference between natural sweet wines and natural dry wines, that the conversion of either one into the other is not a difficult problem. Wine is a fashionable beverage in this country, and fashions fluctuate. These fluctuations are not accom-

panied with a corresponding variation in the chemical composition of any particular class of grapes, but somehow the wine produced therefrom obeys the laws of supply and demand. For some years past the demand for dry sherry has dominated in this country, though, as I am informed, the weathercock of fashion is now on the turn.

One mode of satisfying this demand for dry wine is, of course, to select a grape which has less sugar and more albuminous matter, but in a given district this is not always possible. Another is to gather the grapes before they are fully ripened, but this involves a sacrifice in the yield of alcohol, and probably of flavor. Another method, obvious enough to the chemist, is to add as much albuminous or nitrogenous material as shall continue to feed the yeast-fungus until all, or nearly all, the sugar in the grape shall be converted into alcohol, thus supplying strength and dryness (or salinity) simultaneously. Should these be excessive, the remedy is simple and cheap wherever water abounds. It should be noted that the quantity of sugar naturally contained in the ripe grape varies from ten to thirty per cent—a very large range. The quantity of alcohol varies proportionally when the must is fermented to dryness. According to Pavy, "there are dry sherries to be met with that are free from sugar," while in other wines the quantity of remaining sugar amounts to as much as twenty per cent.

White of egg and gelatine are the most easily available and innocent forms of nitrogenous material that may be used for sustaining or renewing the fermentation of wines that are to be artificially dried. My inquiries in the trade lead me to conclude that this is not understood as well as it should be. Both white of egg and gelatine (in the form of isinglass or otherwise) are freely used for fining, and it is well enough known that wines that have been freely subjected to such fining keep better and become drier with age, but I have never yet met a wine-merchant who understood why, nor any sound explanation of the fact in the trade literature.* When thus added to the wine already fermented, the effect is doubtless due to the promotion of a slow, secondary fermentation. The bulk of the gelatine or albumen is carried down with the sediment, but some remains in solution. There may be some doubt as to the albumen thus remaining, but none concerning the gelatine, which is freely soluble both in water and alcohol. The truly scientific mode of applying this principle would be to add the nitrogenous material to the must.

I dwell thus upon this, because, if fashion insists so imperatively upon dryness as to compel artificial drying, this method is the least objectionable, being a close imitation of natural drying, almost identical; while there are other methods of inducing fictitious dryness that are mischievous adulterations.

* The wine-trade has two rival magazines, both very high-priced, exclusively devoted to its interests, besides others that are partially so.

Generally described, these consist in producing an imitation of the natural salinity of the dry wine by the addition of factitious salts and fortifying with alcohol. The sugar remains, but is disguised thereby. It was a wine thus treated that first brought the subject of the sulphates, already referred to, under my notice. This, although sold to my friend at a good price, was a concoction of the character known in the trade as Hambro' sherry. It contained a considerable quantity of sugar, but was not perceptibly sweet. It was very strong and decidedly acid; contained free sulphuric acid and alum, which, as all who have tasted it know, gives a peculiar sense of dryness to the palate.

The sulphuring, plastering, and use of Spanish earth, described in my last, increase the dryness of a given wine by adding mineral acid, and mineral salts. In a paper recently read before the French Academy by L. Magnier de la Source ("Comptes Rendus," vol. xcviii, page 110), the author states that "plastering modifies the chemical characters of the coloring-matter of the wine, and not only does the calcium sulphate decompose the potassium hydrogen tartrate, with formation of calcium tartrate, potassium sulphate, and free tartaric acid, but it also decomposes the neutral organic compounds of potassium which exist in the juice of the grape." I quote from abstract in "Journal of of the Chemical Society" of May, 1884.

In the French "Journal of Pharmaceutical Chemistry," vol. vi, pp. 118–123 (1882), is another paper, by P. Carles, in which the chemical and hygienic results of plastering are discussed. His general conclusion is that the use of gypsum in clearing wines "renders them hurtful as beverages"; that the gypsum acts "on the potassium bitartrate in the juice of the grape, forming calcium tartrate, tartaric acid, and potassium sulphate, a large proportion of the last two bodies remaining in the wine." Unplastered wines contain about two grammes of free acid per litre; after plastering, they contain "double or treble that amount, and even more."

A German chemist, Griessmayer, and, more recently, another, Kaiser, have also studied this subject, and arrive at similar conclusions. Kaiser analyzed wines which were plastered by adding gypsum to the must, that is to the juice before fermentation, and also samples in which the gypsum was added to the "finished wine," i. e., for fining, so called. He found that "in the finished wine, by the addition of gypsum, the tartaric acid is replaced by sulphuric acid, and there is a perceptible increase in the calcium; the other constituents remain unaltered." His conclusion is, that the plastering of wine should be called adulteration, and treated accordingly, on the ground that the article in question is thereby deprived of its characteristic constituents, and others, not normally present, are introduced. This refers more especially to the plastering or gypsum fining of finished wines (Biedermann's "Centralblatt," 1881, pp. 632, 633).

In the paper above named, by P. Carles, we are told that, "owing

to the injurious nature of the impurities of plastered wines, endeavors have been made to free them from these by a method called 'deplastering,' but the remedy proves worse than the defect." The samples analyzed by Carles contained barium salts, barium chloride having been used to remove the sulphuric acid. In some cases excess of the barium salt was found in the wine, and in others barium sulphate was held in suspension.

Closely following the abstract of this paper, in the "Journal of the Chemical Society, is another from the French "Journal of Pharmaceutical Chemistry," vol. v, pp. 581–583, to which I now refer, by-the-way, for the instruction of claret-drinkers, who may not be aware of the fact that the phylloxera destroyed all the claret grapes in certain districts of France, without stopping the manufacture or diminishing the export of claret itself! In this paper, by J. Lefort, we are told, as a matter of course, that "owing to the ravages of the phylloxera among the vines, substitutes for grape-juice are being introduced for the manufacture of wines; of these, the author specially condemns the use of beet-root sugar, since, during its fermentation, besides ethyl, alcohol, and aldehyde, it yields propyl, butyl, and amyl alcohols, which have been shown by Dujardin and Audigé to act as poisons in very small quantities." In connection with this subject I may add that the French Government carefully protects its own citizens by rigid inspection and analysis of the wines offered for sale to French wine-drinkers; but does not feel bound to expend its funds and energies in hampering commerce by severe examination of the wines that are exported to "John Bull et son Île," especially as John Bull is known to have a robust constitution. Thus, vast quantities of brilliantly-colored liquid, flavored with orris-root, which would not be allowed to pass the barriers of Paris, but must go somewhere, is drunk in England at a cost of four times as much as the Frenchman pays for genuine grape-wine. The colored concoction being brighter, and skillfully cooked, and duly labeled to imitate the products of real or imaginary celebrated vineyards, is preferred by the English *gourmet* to anything that can be made from simple grape-juice.

I should add that a character somewhat similar to that of natural dryness is obtained by mixing with the grape-juice wine a secondary product, obtained by adding water to the *marc*—i. e., the residue of skins, etc., that remains after pressing out the must or juice; a minimum of sugar is dissolved in the water, and this liquor is fermented. The skins and seeds contain much tannic acid or astringent matter, and this roughness imposes upon many wine-drinkers, provided the price charged for the wine thus cheapened be sufficiently high. After this, according to Gardner (Churchill's "Technological Handbook," "The Brewer, Distiller, and Wine Manufacturer"), "the same marc is treated in a similar manner with a fresh quantity of sugar solution, and sometimes undergoes as many as three or four separate macerations, each

successive infusion occupying a rather longer time. It will be easily understood that wine thus prepared costs less than very small beer, though its retail selling price may be regulated by the "*étiquette*" or label (from which I suppose our word ticket is derived) that is finally pasted on the bottles.

The special bouquets and curious flavors demanded by connoisseurs can be more easily added to mixtures largely composed of these second and third runnings than to simple grape-juice having its own grape-flavor, just as the juniper-flavor is more easily added to "silent spirit" than to whisky or cognac. We may thus obtain a clew to the mysterious fact that the market is well supplied with wines bearing the names of celebrated vineyards, of which the whole produce is bought by special contract by certain Continental potentates. Many of these château vineyards are so small that they can not actually produce one tenth of the wine that is *commercially* derived from them.

XLVII.—THE COLORING OF WINE.

Some years ago, while resident in Birmingham, an enterprising manufacturing druggist consulted me on a practical difficulty which he was unable to solve. He had succeeded in producing a very fine claret (Château Digbeth, let us call it) by duly fortifying with silent spirit a solution of cream of tartar, and flavoring this with a small quantity of orris-root. Tasted in the dark, it was all that could be desired for introducing a new industry to Birmingham ; but the wine was white, and every coloring material that he had tried, producing the required tint, marred the flavor and bouquet of the pure Château Digbeth. He might have used one of the magenta dyes, but as these were prepared by boiling aniline over dry arsenic acid, and my Birmingham friend was burdened with a conscience, he refrained from thus applying one of the recent triumphs of chemical science.

This was previous to the invasion of France by the phylloxera. During the early period of that visitation, French enterprise being more powerfully stimulated and less scrupulous than that of Birmingham, made use of the aniline dyes for coloring spurious claret to such an extent that the French Government interfered, and a special test paper, named Œnokrine, was invented by MM. Lainville and Roy, and sold in Paris, for the purpose of detecting falsely-colored wines. The mode of using the Œnokrine was as follows : "A slip of the paper is steeped in pure wine for about five seconds, briskly shaken, in order to remove excess of liquid, and then placed on a sheet of white paper, to serve as a standard. A second slip of the test-paper is then steeped in the suspected wine in the same manner, and laid beside the former. It is asserted that $\frac{1}{100,000}$ of magenta is sufficient to give the paper a violet shade, while a larger quantity produces a carmine red." With genuine red wine the color produced is a grayish blue, which becomes lead-colored on drying. I copy the above from the "Quarterly Jour-

nal of Science" of April, 1877. The editor adds that the inventors of this paper have discovered a method of removing the magenta from wines without injuring their quality, "a fact of some importance, if it be true that several hundred thousand hectolitres of wine sophisticated with magenta are in the hands of the wine-merchants" (a hectolitre is equal to twenty-two gallons).

Another simple test, that was recommended at the time, was to immerse a small wisp of raw silk in the suspected wine, keeping it there at a boiling heat for a few minutes. Aniline colors dye the silk permanently; the natural color of the grape is easily washed out. I find, on referring to the "Chemical News," the "Journal of the Chemical Society," the "Comptes Rendus," and other scientific periodicals of the period of the phylloxera-plague, such a multitude of methods for testing false-coloring materials that I give up in despair my original intention of describing them in this paper. It would demand far more space than the subject deserves. I will, however, just name a few of the more harmless coloring adulterants that are stated to have been used, and for which special tests have been devised by French and German chemists.

Beet-root, peach-wood, elderberries, mulberries, logwood, privet-berries, litmus, ammoniacal cochineal, Fernambucca-wood, phytolacca, burned sugar, extract of rhatany, bilberries; "jerupiga" or "geropiga," a "compound of elder-juice, brown sugar, grape-juice, and crude Portuguese brandy" (for choice tawny port); "tincture of saffron, turmeric, or safflower" (for golden sherry); red poppies, mallow flowers, etc.

Those of my readers who have done anything in practical chemistry are well acquainted with blue and red litmus, and the general fact that such vegetable colors change from blue to red when exposed to an acid, and return to blue when the acid is overcome by an alkali. The coloring-matter of the grape is one of these. Mulder and Maumené have given it the name of *œnocyan* or *wine-blue*, as its color, when neutral, is blue; the red color of genuine wines is due to the presence of tartaric and acetic acid acting upon the wine-blue. There are a few purple wines, their color being due to unusual absence of acid. The original vintage, which gave celebrity to port wine, is an example of this.

The bouquet of wine is usually described as due to the presence of ether, *œnanthic* ether, which is naturally formed during the fermentation of grape-juice, and is itself a variable mixture of other ethers, such as caprilic, caproic, etc. The oil of the seed of the grape contributes to the bouquet. The fancy values of fancy wines are largely due, or, more properly speaking, *were* largely due, to peculiarities of bouquet. These peculiar wines became costly because their supply was limited, only a certain vineyard, in some cases of very small area, producing the whole crop of the fancy article. The high price once

established, and the demand far exceeding the possibilities of supply from the original source, other and resembling wines are sold under the name of the celebrated locality, with the bouquet or *a* bouquet artificially introduced. It has thus come about, in the ordinary course of business, that the dearest wines of the choicest brands are those which are the most likely to be sophisticated. The flavoring of wine, the imparting of delicate bouquet, is a high art, and is costly. It is only upon high-priced wines that such costly operations can be practiced. Simple ordinary grape-juice—as I have already stated—is so cheap when and where its quality is the highest, i. e., in good seasons and suitable climates, that adulteration with anything but water renders the adulterated product more costly than the genuine. When there is a good vintage it does not pay even to add sugar and water to the marc or residue, and press this a second time. It is more profitable to use it for making inferior brandy, or wine-oil, *huile de marc*, or even for fodder or manure.

This, however, only applies where the demand is for simple genuine wine, a demand almost unknown in England, where connoisseurs abound who pass their glasses horizontally under their noses, hold them up to the light to look for beeswings and absurd transparency, knowingly examine the brand on the cork, and otherwise offer themselves as willing dupes, to be pecuniarily immolated on the great high altar of the holy shrine of costly humbug.

Some years ago I was at Frankfort, on my way to the Tyrol and Venice, and there saw, at a few paces before me, an unquestionable Englishman, with an ill-slung knapsack. I spoke to him, earned his gratitude at once by showing him how to dispense with that knapsack abomination, the breast-strap. We chummed, and put up at a genuine German hostelry of my selection, the Gasthaus zum Schwanen. Here we supped with a multitude of natives, to the great amusement of my new friend, who had hitherto halted at hotels devised for Englishmen. The handmaiden served us with wine in tumblers, and we both pronounced it excellent. My new friend was enthusiastic; the bouquet was superior to anything he had ever met with before, and if it could only be fined—it was not by any means bright—it would be invaluable. He then took me into his confidence. He was in the wine-trade, assisting in his father's business; the "governor" had told him to look out in the course of his travels, as there were obscure vineyards here and there, producing very choice wines, that might be contracted for at very low prices. This was one of them; here was good business. If I would help him to learn all about it, presentation cases of wine should be poured upon me forever after.

I accordingly asked the handmaiden, "Was für Wein?" etc. Her answer was, "Apfel Wein." She was frightened at my burst of laughter, and the young wine-merchant also imagined that he had made acquaintance with a lunatic, until I translated the answer, and

told him that we had been drinking cider. We called for more, and recognized the "curious" bouquet at once.

The manufacture of bouquets has made great progress of late, and they are much cheaper than formerly. Their chief source is coal-tar, the refuse from gas-works. That most easily produced is the essence of bitter-almonds, which supplies a "nutty" flavor and bouquet. Anybody may make it by simply adding benzole (the most volatile portion of the coal-tar), in small portions at a time, to warm, fuming nitric acid. On cooling and diluting the mixture, a yellow oil, which solidifies at a little above the freezing-point of water, is formed. It may be purified by washing first with water, and then with a weak solution of carbonate of soda to remove the excess of acid. It is now largely used in flavoring as essence of bitter-almonds. Its old perfumery name was essence of mirbane.

By more elaborate operations on the coal-tar product, a number of other essences and bouquets of curiously imitative character are produced; one of the most familiar of these is the essence of jargonelle pears, which flavors the "pear-drops" of the confectioner so cunningly; another is raspberry flavor, by the aid of which a mixture of fig-seeds and apple-pulp, duly colored, may be converted into a raspberry jam that would deceive our prime minister. I do not say that it now is so used, though I believe it has been, for the simple reason that wholesale jam-makers now grow their own fruit so cheaply that the genuine article costs no more than the sham. Raspberries can be grown and gathered at a cost of about twopence per pound.

With wine at sixty shillings to one hundred shillings per dozen the case is different. This price leaves an ample margin for the conversion of "Italian reds," catalans, and other sound, ordinary wines into any fancy brands that may happen to be in fashion. Such being the case, the mere fact that certain emperors or potentates have bought up the whole produce of the château that is named on the labels does not interfere with the market supply, which is strictly regulated by the demand.

Visiting a friend in the trade, he offered me a glass of the wine that he drank himself when at home, and supplied to his own family. He asked my opinion of it. I told him that I thought it was genuine grape-juice, resembling that which I had been accustomed to drink at country inns in the Coté d'Or (Burgundy) and in Italy. He told me that he imported it directly from a district near to that I first named, and could supply it at twelve shillings per dozen, with a fair profit. Afterward, when calling at his place of business in the West End, he told me that one of his best customers had just been tasting the various dinner-wines then remaining on the table, some of them expensive, and that he had chosen the same as I had; but what was my friend to do? Had he quoted twelve shillings per dozen, he would have lost one of his best customers, and sacrificed his reputation as a high-class

wine-merchant; therefore he quoted fifty-four shillings, and both buyer and seller were perfectly satisfied: the wine-merchant made a large profit, and the customer obtained what he demanded—a good wine at a "respectable price." He could not insult his friends by putting cheap twelve-shilling trash on *his* table!

Here arises an ethical question. Was the wine-merchant justified in making this charge under the circumstances; or, otherwise stated, who was to blame for the crookedness of the transaction? I say the customer; my verdict is, "Sarve him right!"

In reference to wines, and still more to cigars, and some other useless luxuries, the typical Englishman is a victim to a prevalent commercial superstition. He blindly assumes that price must necessarily represent quality, and therefore shuts his eyes and opens his mouth to swallow anything with complete satisfaction, provided that he pays a good price for it at a respectable establishment, i. e., one where only high-priced articles are sold.

If any reader thinks I speak too strongly, let him ascertain the market price per pound of the best Havana tobacco-leaves where they are grown, also the cost of twisting them into cigar-shape (a skillful workman can make a thousand in a day), then add to the sum of these the cost of packing, carriage, and duty. He will be rather astonished at the result of this arithmetical problem.

If these things were necessaries of life, or contributed in any degree or manner to human welfare, I should protest indignantly; but seeing what they are, and what they do, I rather rejoice at the limitation of consumption effected by their fancy prices.

A NATURALIST'S EXCURSION IN DOMINICA.

By Dr. FR. JOHOW.

THE British Island of Dominica, although it forms only an insignificant colony, takes a rank among the first of the West Indies, when considered in regard to the richness of its scenery. Built up of lofty volcanic masses, which interpose almost insurmountable rocky barriers to the entrance of civilization into the interior, it still conceals among its hills and ravines a life of animals and plants rejoicing in the wildest freedom, and which is developed under the moist, tropical climate into extreme luxuriance. If one desires to make himself acquainted in the shortest possible time with the life of the island, he can do no better than make an excursion to the "Boiling Lake," that wonderful hot water-crater in the interior, which is one of the most curious geological phenomena of the earth. The road of about fifteen miles, but which it takes two or three days to traverse, so rugged is it,

from the west coast, passes through cultivated and half-tilled lands into a romantic river-valley, and then through the primitive wilderness over hills and mountain-torrents, into an upland valley about three thousand feet above the sea, in the bottom of which lies the boiling lake, surrounded by a grim waste of volcanic rocks.

The starting-place for our excursion is the little town of Roseau, the chief place of the island, and the only one where the traveler will find a boarding-house, situated on the west coast, picturesquely set down at the mouth of a romantic valley, among sugar-cane fields and palm-gardens, and framed by forest-covered mountains. Before starting on our excursion we will make a short study of the shore, a flat beach of sand and gravel, sunny, hot, and dry, but which supports a characteristic vegetation. We are struck, in looking at this beach-flora, with the predominance of the creeping plants, by which the most diversified botanical families are represented. Their habit of growth, with the multitude of rooting points it permits, gives them great advantages in keeping their hold on the shifting sands, and access to numerous points at which they may tap the soil for its scanty supplies of moisture. The succulent nature of the organs is another peculiarity of these plants that will strike the Northern observer. Most of them, whether they be creepers or upright, are either provided with fleshy leaves, or consist of amorphous thick stems without expanded foliage. This property, which must be regarded as a provision to diminish transpiration, is, as every one knows, not uncommon in the vegetation of dry places. In the tropics it marks not only the shore plants and the vegetation of the arid plains, but also the epiphytes, which live upon the dry bark of the trees. European species are represented in this growth by the portulaccas. Among the plants is one, *Bryophyllum calycinum*, which has long been known to gardeners and botanists by the faculty which its leaves possess, when broken off and laid upon the ground, of developing buds on their edges, which finally become independent plants. This, instead of being a merely adventitious peculiarity, marked only under special circumstances, as has been supposed, is really the normal provision of Nature for the propagation of the plant. This species forms in the course of its growth two kinds of leaves; the entire leaves of the young plant, which are shaped like those of the common live-forever, and, at a later stage of growth, cleft leaves. The two kinds of leaves are not equally competent to form buds, but the property is a peculiarity of the cleft ones. When we gently draw the hand over a well-grown plant of *Bryophyllum*, we will find the feathered leaves falling like ripe fruits to the ground, while the entire leaves remain fixed upon the plant and will not be disturbed by any shaking. Examining the fallen offsets a few days afterward, we will find their upper surfaces crowned with a circle of sprouts around the edges, while to the lower side is attached a tuft of young rootlets. The plantlets live at first on the nourishing matter of the

young leaf, but soon become wholly separated and acquire an independent existence, to become in turn parents of a new brood. Some other plants multiply by offsets from the leaves, but the exhibition of a differentiated propagation-leaf is peculiar to this one. Among the trees that attract our attention is the shore-grape (*Coccoloba uvifera*), with its curious knotted and bushy growth, and its thick, hard leaves, which is found nowhere but in the Antilles. It offers an odd combination of the creeping and upright growths: in the isolated specimens, the lower limbs bend down and run along the pebbly beach, but without taking root; while the upper limbs spread themselves out in the air, at this time hung with whitish flower-spikes, which are later to develop into the dark-blue "grapes of the shore." On the beach a few miles north of Roseau are some plants of the manchineel-tree (*Hippomane mancinella*), now becoming quite rare, which is fabled to be deadly to all who sleep under it. The thing that is true about this myth is, that the sap contains an acrid poison that causes painful sores on the skin. The botanist Jacquin, who visited the Antilles in the middle of the last century, says that no animal would touch the fruit of the manchineel, though the ground under the trees was covered with it and inhabited by innumerable crabs. Jacquin denies that there is any danger in sleeping under the trees, because he and his companions rested under one of them for three hours without feeling any inconvenience from it. In his time, manchineel-wood was used for fine cabinet-work, and was obtained without risk from poisoning by building a fire around the tree, by which the greater part of the sap was boiled out, and then cutting it down very carefully with the face veiled. The *Capparis cynophallophora* attracts notice by its curiously shaped flowers, conspicuous through their numerous long, cream-colored filaments which, drooping when they first come from the buds, gradually erect themselves into an umbel of elastic threads. They are visited by hosts of insects, which, striking against the stamens in their efforts to reach the nectaries, set them into rapid motion and become dusted with the pollen, and are thus constituted bearers of it to other flowers; for the *Capparis* is proteranderous, and only the pistils of flowers that have already cast their pollen are capable of being fertilized. Conspicuous objects are the papilionaceous flowers of the *Erythrina corallodendron*, which, the tree being leafless at this season, reveal themselves to a vessel approaching the coast in bunches of gorgeous scarlet.

If we continue our excursion till sunset, we are overtaken in returning to the town by the sudden coming on of darkness, for the twilight is very short in this low latitude. But, hardly has the departed sun ceased to gild the crowns of the cocoa-palms, than the moon sheds her soft light through the delicately feathered foliage of the tamarind-trees under which we are walking. With every succeeding minute the crowns of these trees grow more transparent and open; for the leaves

are putting themselves to sleep, and folding their filaments up against their petioles.

Early in the morning we start for our first night-station, the negro village of Laudat, seven miles from Roseau, in the mountains. We might go on horseback, but prefer a way that will give opportunity for close biological observations; so, having a negro to carry our baggage and botanical books, we start out, armed with umbrella, gun, and opera-glass, with which to scan inaccessible specimens in the tree-tops, on foot. As we pass through the cultivated lands, we admire the areca and cocoa palms, but are disappointed with the banana-trees, whose leaves have been torn to shreds by wind and rain, and find the bread-trees at this season presenting but a sorry spectacle. The dark masses of the mango-trees make a better impression, and it is impossible to repress admiration of the calabash-trees (*Crescentia cujete*), with great pumpkin-fruits hanging from the tips of their slender limbs, and which are devoted to such varied uses: the fruit-pulp to be made into a vegetable viand; the pumpkin-shell into vessels and dishes of every sort; and the outer bark by the West Indian orchid-growers as the ground on which to cultivate their fancifully shaped floral treasures. As we examine the plants by the roadside, many of them stragglers from the sea-shore or from foreign parts, we are struck with the variety of the provisions by which they adapt themselves to resist the heat and aridity of the dry season. We have already mentioned the succulent stems and the condensed surface of the beach plants, and the leafless condition of the coral-tree (*Erythrina*), which other *Leguminosæ* also assume during the heats. These and other peculiarities for the same end are exhibited not in the same degree for all of the species, but with numerous individual variations according to the special circumstances of each particular plant, and in such a way as to demonstrate a capacity for individual adaptation. Here are, close together, two specimens of the *Bryophyllum calycinum*, one standing in the open sunlight, and the other under the shadow of an acacia-tree. The former plant has relatively small, thick leaves, the structure of which is seen under the microscope to be close and made up of palisade-like cells; while the other one displays much thinner and more loosely built leaves, exposing many times as much surface to the light as its companion did. Another method of adaptation is shown in the posing of the surface of the leaves parallel to the sun's rays instead of perpendicularly to them. This position in profile sometimes occurs as a peculiarity of the species; is sometimes brought about by the version or folding of the leaf-blades; and is sometimes dependent upon periodical movements of the leaves, which seem to be provided with particular organs for the purpose, according to the intensity of the light. The profile position appears to be fixed in the shore-grapes, which we observed on the beach, in the sapoteas, and in some other species. The faculty of folding the leaves appears rather to be one of individual

adaptation. The leaves of the *Bryophyllum* appear folded in the sun, spread out flat in the shade; and the same phenomenon was observed in a modified form in the very abundant *Psidium Guava* and some other species. Other plants form close and hard cuticles which restrict evaporation, and some others appear to be furnished with special water-vessels in their hypodermic layers. To this class seem to belong the thick-leaved calabash-trees and shore-grapes, and the creeping *Commelyaceæ.*

From admiring a number of highly colored flowers, our attention was drawn to the modest sensitive-plant (*Mimosa pudica*), which was here growing in masses as a common weed alongside of the cultivated fields. A goat was feeding along the hedge-side, and had stretched out his tongue toward the delicate mimosa-leaves, but had not reached them, when he suddenly drew his head back in astonishment at the strange sight of an array of sharp thorns, forbidding closer approach, where he had only an instant before anticipated the taste of a mouthful of delicious foliage. The mimosa thus protects itself against the unwelcome feeder upon it in the same manner as the hedgehog escapes his enemies by rolling himself up into a prickly ball. Now was explained to us the observation we had made before in the country, of islands of mimosa-plants rising untouched from the pastures in which all the other plants around them had been closely eaten away. The same property of withdrawing itself from unfriendly contact operates to protect the mimosa against injury from wind and rain.

As we go up the mountain-walled valley of the Roseau, in the intervals of which cultivation still presses hard upon the primitive vegetation, we admire the variety and brilliancy of the extra-floral display by which some of the species are made conspicuous, and which is one of the marked features of the West Indian flora. Here is a begonia, with rose-red peduncles; there are some bromelias, with brightly colored bracts attached to their flower-stocks. The *Heliconia,* or wild-banana, is marked from afar off not more by its enormous leaves than by the brilliant purple spathe that surrounds its unobtrusive inflorescence; and the *Euphorbia heterophylla* is equally distinguishable by the patches of crimson on the whorl of leaves nearest to its flowers; while many other plants have their real leaves variegated with stripes or spots of color. Of most graceful and noble bearing are a group of tree-ferns, the unapproachable delicacy of whose leaf-carving, the remarkable harmonizing of the green of their foliage with the dark brown of their stems, and the perfect symmetry and pose of their crowns, are worthy of and receive the highest admiration. As we continue the ascent, the wood becomes largely composed of the *Bursera gummifera*, a tree of the terebinth family, the magnificent stems of which are supported by wide-spreading pillar-roots and varnished with the white balsam that has exuded from their bark. Moss-like plants nestle under the shelter of the root-pillars, lianas climb around the

trunks, and multitudes of epiphytes flourish in their airy crowns, among which we are surprised to see the *Clusias*, themselves trees, enthroned high upon the topmost limbs. From the height of more than a hundred feet these parasites, called in the country "Scotch attorneys," and "cursed fig-trees," send their rope-like, tufted air-roots clear to the ground, to draw up water and food to their lofty abode, while they establish their mechanical security on the stem of the mother-tree by a close network of holding-roots. Sometimes the *Bursera* dies in the embrace of the strangler, and its trunk molders away without crumbling up, within its tight envelope, and finally falls, if it is not held up by the vines, bringing its destroyer down with it.

At Laudat, where we are to spend the night, two thousand feet above the sea, we find a better opportunity than we have ever before enjoyed to become acquainted with the structure and habits of the epiphytic phanerogams. At all other places on the island these plants live in the tree-tops, and we have to content ourselves with looking at them through the glass, or to rely for more careful examination upon such specimens as we can bring down with the gun. Here, where the forest has been cleared away for several acres, these plants have come down with the trees, and, finding enough light near the ground, live upon the bushes. They have been quite fully described by A. W. F. Schimper, in the "Botanisches Centralblatt," and we check our own observations by his account. Most of the epiphytes of Laudat belong to the families of the orchids, aroids, bromelias, and ferns, while many other families are represented by individual forms.

The peculiar conditions under which these plants live require peculiar adaptations. One of their most general characteristics, and frequently a very prominent one, is the succulent or leathery constituency of their leaves, which, operating to impede transpiration, well adapts them to the dry conditions of their dwelling-place. Some of them are protected by a clothing of hairs. Many epiphytes are characterized by superficial extensions of their organs at relatively small heights above their substratum ; quite usual are the arrangement in rosettes of the leaves at the base of the stem, thickenings of the stem into knots, and a creeping or climbing habit—all peculiarities denoting adaptation to the absorption of water and food, and to the gaining of a secure footing on the substratum. In the way of special adaptations, we may, with Schimper, distinguish among the epiphytes four groups, according to the manner in which they take up their food.

Those of one group simply derive their nourishment from the bark to which they are attached, and are in this respect analogous to the ground-plants. Those of the second group send down roots to the ground, besides those by which they adhere to the tree, and thus put themselves as to nourishment in almost precisely the condition of ground-plants. Of these are the *Clusia*, which we have described, and two plants which were conspicuous at Laudat, by their handsome flow-

ers and the luster of their leaves. In some epiphytal orchids, aroids, and ferns, the roots weave themselves on their bark support into something like birds' nests, in which are gradually accumulated dead leaves and other organic *detritus*, to form a humus. The fourth class, to which the bromelias belong, is distinguished from all the others by the fact that water and food are taken up by the leaves, while the roots are either not developed, or are reduced to mere organs of attachment. The *Tillandsia usneoides* ("Spanish moss"), which, having no roots, hangs from the limbs, is clothed with a silver-gray hair, having shield-like processes which represent water-absorbing organs. Other epiphytic bromelias have similar absorptive vessels, and special provisions in the dish-like arrangement of the leaf-rosettes for storing rain-water and dew and more solid food for a considerable time. One may be convinced in a very instructive manner of the presence of water in these leaf-basins, by bending down a limb covered with epiphytes, when, unless he proceeds very carefully, he will receive a quart or more of water on his head. We learn from these considerations that these epiphytes are not real parasites, but only tenant forms, which, fixing their homes on other plants, derive their food support from the atmosphere and from dead matter. There are, however, besides these, real parasites at Laudat, which prey upon the living wood of the trees.

Among the forms of animal life at Laudat are three humming-birds, one of which is so tame that the children catch it in their hands, and another is hardly two inches long; and, in sharp contrast with them, the largest of all insects. This is a beetle, which entomologists have named, in recognition of its gigantic size and great strength, *Dynastes Hercules*. The male is armed, like our stag-beetles, with two immense tusk-like processes on the head, the physiological significance of which is unknown. The female is unarmed, and of much more slender constitution.

So absorbed were we in the contemplation of the new forms of life around us that we would have been unmindful that the afternoon was passing away were it not that a bird called out to inform us that the sun would set in half an hour, and ten minutes later it would be dark. The sunset-bird, as the American Ober, who discovered it in this island, has named it in his "Camps in the Caribees," utters its peculiar cry only twice during the day—half an hour before sunrise, and as long before sunset—and keeps complete silence for the rest of the day. For a very brief interval after sunset the air is perfectly clear and transparent, and the light-effects are most picturesque; then, as if some signal had been given, begins the concert of the tree-frogs and locusts, and finally darkness settles over the landscape, to be broken up shortly by the rising of the moon, whose light gives a new series of picturesque effects.

Early in the morning we are awakened for a bath at the junction

of two brooks, one bringing warm water from the mountains and the other cold water from springs, where we may take our choice between the temperatures, or of a mixture of the two, or between a douche and a plunge-bath, and for our final start to the boiling lake. There are two bodies of standing water on the island: one is called the fresh-water lake, and is cold; while, though lying at a considerable height above the sea, and probably occupying an extinct crater, it is less remarkable for its geological features than for the beauty of its surroundings. The other, the "Boiling Lake," is the object of our excursion. Soon we entered upon a dark wood of painful grandeur. The trees were so large and tall that we were not able with the naked eye to distinguish the forms of the leaves, the flowers, or the fruit upon a single one of them. Even our guns could not reach the atmospheric vegetation, and we had to content ourselves with the examination of casual fallen specimens, or with pulling at the ropy air-roots of the clusias, when the pouring of water into our faces would inform us that there were tillandsias and brocchinias above. Of animal life, we observed a curious rodent occasionally dashing quickly across the way, but no large mammalia, and two large brightly colored parrots peculiar to the island, of which we did not succeed in getting any specimens. It is a remarkable fact that most of the birds of Dominica are found nowhere else. The ornithologist Ober, who visited Dominica in 1880–'81 and studied its birds, was surprised to remark that a very considerable proportion of them were of perfectly new species. Another species that must not be forgotten is one of large land-crabs which run over the ground, and of which Ober records the habit of going every year in the same month to lay their eggs in the salt-water, where they may be met by thousands and thousands. In a short time we reach a mountain-river of clearest water, which is called the Breakfast River, because excursionists to the boiling lake, reaching it at about ten o'clock in the morning, are accustomed to stop and rest awhile and take their breakfast.

On the other side of this stream we have to climb a steep, bush-clad rock-wall, till in an hour we reach the top of the mountain and look on a panorama of astonishing magnificence. Behind us in the west lies the forest we have traversed, and the narrow green valley of the Breakfast River. Before us in the east stretches a bare, ravine-cut waste, strewed with volcanic stones and yellow sulphur-beds, and seething with hot springs, streams, fumeroles, and solfataras, covered with the remains of destroyed woods, and crowned with a pillar of vapor reaching to the clouds. Beyond a turn of the valley at our feet sounded a dull rumbling, which with the vapor indicated to us the direction in which the boiling lake lay. We scramble over the steep cliff into the valley through a wood of trees burned to a cinder, but yet standing. This desolation was occasioned by an eruption of the lake, which took place in 1880, by which immense masses of glow-

ing ashes and hot mud were thrown over the wooded valley-wall. Between the grim trunks, which are so brittle that they crumble at the slightest push, and which offer not the least of the obstacles to our descent, the ground is covered with ejected matters and pebbles, with here and there some plant growing in the interstices. In the bottom of the valley flows a warm, steaming stream, which is fed by little brooks rushing down on every side, foaming between the blocks of stone. Most of these affluents run with colored water—one blue, another yellow, a third milk-white, a fourth maroon, etc., according to the mineral constituents which it holds in suspension or solution. At many places aqueous and sulphurous vapors issue from the ground as if from the valves of a steam-engine, and here and there is a steaming basin from which escape tumultuous blasts of gas. The bed of the stream is beset with great bowlders, over which we have to find our way with much difficulty and some danger by springing from one to another. Finally we reach the edge of the boiling lake in a state of extreme exhaustion.

A glance into the infernal caldron that lies before us informs us that we are standing here at the mouth of a still active volcano. The basin of the lake lies in the midst of a deep, steeply descending cup, the crater, to which two streams come from the north. One of the streams brings cold chalybeate water, and runs by the basin to unite with its warm effluent; the other, bringing warm water, empties into the boiling lake. On the south side of the crater gaps an opening in the wall which constitutes the outlet of the lake. It is of quite recent origin, for it dates only from the great catastrophe of 1880, in which the valley-forest was destroyed. Previous to this time the area of the lake was about three times as great as it is now, when its diameter is only about forty-five paces. In the center of the basin is a geyser issuing from a mound of black mud, which, when we observed it, spouted to a height of some fifteen or twenty feet. Other observers have given it a height of from sixty to a hundred feet. In the interior of the mud-heap of the geyser we remarked, whenever the wind blew the steam away, a kind of tufaceous structure, of which we were not able to learn anything more exactly. Great masses of sulphurous gas escape over the whole surface of the basin from the black, muddy fluid, and keep up a loud roaring and humming, which only heightens the dismal aspect of the whole place.

This was the end of our excursion into the interior of Dominica. —*Translated for the Popular Science Monthly from Kosmos.*

ENGLISH EXPERIENCE WITH CANCER.

By H. PERCY DUNN, F. R. C. S.

THERE is reason for the frequent inquiry which meets the ears of medical men in the present day, Is it not true that cancer is increasing? For, however much we may attempt to throw into the shade our convictions upon this matter, the records of the Registrar-General remain to show, in all the obtrusiveness of an unvarnished statement, the annual increasing mortality from this terrible disease. A reference to the forty-third annual report of the Registrar-General discloses a somewhat alarming state of things, in connection with which it must be conceded that reflection affords but little assistance in the attempt to solve the cause. According to the report, 80,049 deaths from cancer occurred during the ten years from 1860–'69 inclusive, and the annual average increase was 248. During the years 1870–'79 the total number of deaths from cancer was 111,301, and the annual average increase was 320. As far, therefore, as numbers are capable of showing, we have here conclusive evidence of the increment in the mortality from cancer. It is observable also that the rate of increase is much higher in the latter than in the first ten years. It is, moreover, the case that the annual rate of increase is higher in the years 1860–'69 than in the preceding decennium—namely, in the years 1850–'59. In short, in the years 1850–'59 the increment was about 2,000; in 1860–'69, 2,400; in 1870–'79, 3,200. We have then confessedly to face the fact that cancer is increasing in our midst at a rate which bids fair to become more and more serious with the advance of time. In an article entitled "An Inquiry into the Causes of the Increase of Cancer," published in the "British Medical Journal" a year ago, I drew attention to the observations which had been made upon the subject by the late Charles Moore, whose investigations into the pathology of cancer had brought under his notice the incontrovertible evidence of the increase of the disease. In the year 1865 he published a small book called the "Antecedents of Cancer," the contents of which chiefly consist in an attempt to explain in what manner the augmentation of cancer is influenced by the circumstances of life prevailing in this country. For instance, he held that the introduction of corn laws, the discoveries of gold and sanitary improvements, whereby the well-being of the nation was conspicuously established, affected cancer indirectly by bringing into prominence the predisposing causes of its occurrence; and good living, it is thought, which follows as a corollary of commercial prosperity, is intimately associated with the manifestation of cancer. Again, inasmuch as cancer is characteristic of the healthy, it may be expected to abound amid the conditions of health. The greater prevalence of the disease among the rich than among the poor can probably be explained in this manner. According to a French observer, the proportion of cancer in the wealthy classes is about 106

in 1,000, in the poor classes it is 72 in 1,000 ; or at a rate in the former case of ten per cent, and in the latter of seven per cent. Now, curious as it may seem, cancer is met with in the lower animals ; and it has been said to prevail more frequently among those which are flesh-eaters than those which are herb-eaters. It has been stated by the late Dr. Crisp, who had good opportunities of judging, that cancer is by no means an uncommon disease among the domesticated animals, while in wild animals and uncivilized man it is rare. In 230 also of the quadrumana which he had examined there were no traces of cancer. Thus the inference to be drawn from these statements appears to be plain. It is almost conclusive that the habits of life, either in man or the lower animals, are concerned in the production, or at least in the predisposition, to cancer. The surroundings, it is conceivable, of an autochthonic existence do not include influences which favor the production of the disease ; consequently, in uncivilized man the disease is rare. It is, however, different when man becomes civilized, for then the predisposing, if not exciting, causes come into play, and man has entered an area of life in which the disease has acquired not only a pronounced but an augmenting fatality. And the same is true of animals. Now, as far as we know at present, cancer has not a zymotic origin ; in other words, it does not arise from any micro-organism or "germ." It is consequently neither infectious nor contagious. Cancer, in short, can neither be "caught" nor "given." It commences *de novo* in each individual whom it attacks. There is, moreover, no such thing as anything cancerous being transmitted from parent to child in the cases in which the disease occurs in one and the other. It is possible to inherit a predisposition to cancer—that is, if cancer appears in a family, the members may be said to possess a liability to the disease, but practically this statement does not convey with it much significance, because, until the disease becomes manifest, no person can be said to be cancerous, inasmuch as he does not inherit the disease, but simply the liability to it. We are confronted with the problem of how to limit the frequency of the disease, and the difficulty of this is apparent in view of the fact that we know almost nothing of its origin. Cancer, as I have said, is not contagious ; it stands almost alone as a disease which increases with our prosperity, and, while our health laws are raising the standard of public health, the mortality from cancer stands forth as a blot upon the results, detracting in part at least from the measure of the success that has thus far been obtained. Observation has shown that cancer has a certain geographical distribution. It prevails extensively in some parts of the globe, and is scarcely known in others. For instance, it is met with most largely in the central parts of Europe, but in the extreme north of this continent the inhabitants enjoy an almost complete immunity from cancer. It is stated to be unknown in the Faroe Islands, while in Iceland in one year it proved mortal in only thirty-seven cases out of 50,000 inhabit-

ants, or in a proportion of 0·07 to 1,000. With reference to England in this connection, Englishmen may be regarded as unfortunate; for within the geographical area of these islands cancer asserts largely malignant and fatal influence. It afflicts mankind chiefly at an age at which, by universal consent, life is best enjoyed. Many and various have been the attempts devised to combat the inevitable fatality of its accession. A few years ago, a drug, Chian turpentine, was somewhat extensively employed, its introducer, Dr. Clay, claiming that under its influence cancerous tumors would gradually diminish in size, and ultimately dwindle away. But, unfortunately for humanity, various scientific trials, prosecuted with uncomplaining forbearance on the part of the sufferers, yielded in the end negative results, and Chian turpentine was again relegated to the obscurity from which it had emerged for a brief space of time. The gleam of light, however, which has shed some radiancy over the gloominess of cancer, comes from surgery. It may be said of the surgery of the present day that better results are obtained from the surgical treatment of cancer than was probably the case in any former age. Some operations are now being practiced which hitherto were not considered justifiable, owing to the want of success which followed their performance. Others have lately been introduced, the practicability of which has proved the wisdom of their conception. Sufferers from cancer who formerly would not have been relieved are, in the present day, benefiting from the application of the principles of scientific surgery. Years of life—some years at least—and the mitigation of much physical and mental suffering, fall to the lot of surgeons to confer. Even the stomach, which in the male after a certain age commonly becomes the seat of cancer, has been dealt with, and a portion of it removed which was diseased, the result being favorable in so far as suffering was relieved and life prolonged. It must be, however, remembered that the successful treatment of cancer depends as much upon its early recognition as upon the means adopted for its relief. There should be no hesitation in ascertaining the nature of a tumor or swelling which is suspicious or uncertain. The improvements in the methods of diagnosis enable surgeons to recognize cancer in its earliest stages; and as soon as the presence of the disease becomes unequivocally demonstrated the probability of a successful result is largely enhanced by its early removal. The reason for this is obvious. Cancer commences in each person presumably as a local disease. But it spreads and infects by means of the blood-vessels and lymphatics, first the nearest lymphatic glands and then the more distant organs of the body. When this has occurred, the disease is no longer a local one, it has become what is called constitutional. It is therefore manifest that the most favorable time at which to obtain the best results from surgical interference is when the disease persists simply as a local growth, and when the blood and tissues of the body have not received the impress of a cancerous taint.—*Pall Mall Budget.*

SUPERSTITIONS ABOUT THE DOLPHIN.

By Dr. BIEDERMANN,
OF THE GYMNASIUM OF HALLE.

NO animal of the sea or land figures more frequently in the fanciful creations of the Greeks and Romans than the dolphin, king of the Mediterranean Sea. It is represented in their myths as an attribute, symbol, companion, and servitor of the mighty gods, who were themselves not ashamed to borrow its form ; in the epics as the friend and deliverer of the Grecian heroes, even of historical men, whom it carried on its back over the waters ; in the stories as the playmate and fondling of handsome boys, whose death it could not survive. As in poetic art, so was it also adopted as a form of beauty down to the latest after-bloom of Roman plastic arts of design, equally in painting and as an ornament on the articles of daily life, on vases, coins, and cut stones, on the borders of Etruscan mirrors, etc. It is not strange, then, that these motives entered even the scientific work of antiquity, and the dolphin was elevated into an ethical type of the animal world. Ælian ascribed to it a parental love that did not fear death for the sake of its young. The mother would not forsake her young one when it was caught, but would share captivity and death with it ; if one of two was taken, the mother would drive the other away from the danger, and then go back to perish with the caught one. Ælian tells of many such traits which seem to reveal a kind of human nature in the dolphin, and to connect it most intimately with man and his sea-life. Dolphins were said to accompany the ship of the hardy sailor over the solitary sea, to endeavor to entertain him with their sportive movements, and to be so confiding that, if they were called by the name of Simon, they would come up and help the fisherman in his work of driving the fish into his net. They forewarned him of the storm, also had a good feeling toward bathing boys, and exhibited thankfulness toward man. The spiritual qualities of the dolphin appeared not less deep to antiquity. If a dolphin was caught, he would greedily eat all the fish that were caught with him, then would break the net and escape ; hence the wise fisherman, if he casually caught a dolphin, would draw a rush through his nose and let him go, marking him for another time. That such an animal, to which a lavish fancy ascribed so many noble qualities, should have enjoyed in reality a certain degree of honor and indulgence, follows as a matter of course, especially when it is remembered that the dolphin was of little value when caught, but when at large could often make himself very useful by driving up the smaller fishes toward the nets, as the whale does in the herring-fishery. The southern people, who were otherwise not particular as to the quality of their food, spared the dolphin, and it is still considered inviolable on the Sea of Marmora. With a few exceptions, dolphins were abhorred by

the cultivated classes. The Byzantines had so little regard for them that they caught them and salted them. It was not thought amiss to make them of use in medicine according to the presumed laws of sympathy and homœopathy. The fat of the dolphin, eaten with wine, would cure hydrocephalus; its teeth would ease the teething of children, if the proper bones were rubbed upon the gums or burned to ashes and taken; and they served as amulets to protect against sudden dangers. To dream of this wonderful animal signified good, while the dreaming of any other creature of the water betokened evil.

Such representations by the ancients were the more singular, because the dolphin in reality is so strikingly different from them. According to science, the dolphin is the boldest, most greedy, and fiercest robber of the sea, the terror of the smaller fish, especially of the flying-fish, which leaps into the air in fear of it. How was it possible, in the face of qualities so directly opposite, for the dolphin to be made the pet of poetic and figurative art among a people who were otherwise so keen in their perceptions? The question may be answered, generally, by considering the two fundamentally different points of view from which the ancients and the moderns regarded the animal world. The Greeks, and still more the people of the middle ages, were generally inclined to put the realistic and scientific side in the background, and to look at animals from the religious, moral, and sentimental point; the humoristic-satirical character of the romantic and Germanic animal-poetry of the middle ages is a departure in another direction. It would, however be a mistake, and would underrate the clear comprehension of reality possessed by the Greeks, to suppose that all these traits of dolphin-life were mere fancy-pictures. The dolphin was observed correctly on the whole, but the lively imaginative faculty of the sailors and fishermen, easily moved to exaggeration in contemplating the immensity of the sea, unconsciously underlaid the natural behavior of these animals with moral motives. With later peoples, those traits were exaggerated on the sentimental side. Large schools of dolphins followed the sailors in clear weather and amused and entertained them with their arrow-like movements, and with the gracefully waving lines which they left on the waters, while everything else avoided the ship. It was easy for them to imagine that all this was done for their sake, and in consequence of the dependence of the animal upon man. The fancy naturally arose that the dolphin by his movements warned men of approaching storms; and it became regarded as a power and a symbol of the sea and sacred to Neptune. As the lion was king of the animals of the land, so was the dolphin king of the animals of the sea; and as the former, according to the story, ate apes to renew his strength in his old age, so did the dolphin prolong his life to three hundred years by eating sea-apes. Thus a humanizing of Nature took place in this fancy of the Greeks, as in everything else they looked at. It was imagined that the dolphin could call with a whistle, and when

this was believed, it became a sure evidence to the Greeks that the animal must have once been a man, one of the wild, piratical, Tyrrhenians whom Dionysus in punishment changed into a dolphin. Out of this grew the idea of the moral attributes that were ascribed to the animal, its parental love, its humors, etc. Thus it became still more appropriately a symbol of the sea and a constant companion of Neptune, while its speed was compared with that of the horse, a creature of Neptune's. It was the dolphin that hunted up Amphitrite when she fled to the depths of the sea to avoid a marriage with Neptune, and guarded her till the god led her home as his spouse; and Neptune, in recognition of its skill and fidelity, made it his sacred animal, and set it as a constellation in the northwestern sky. Thus it came also that Ulysses, the ideal sailor, carried the symbol of the dolphin on his shield and wore it engraved on his signet-ring.

These mystic views of the animal were impressed on other people, and found expression in new tales and forms. Conrad, of Megenburg, the first German naturalist, introduced them to the Germans in the fourteenth century, to whom he described the dolphin as an animal without malice, living to be a hundred years old, loving music and friendly to men, and told the story of Arion and the boys with the dolphin. The Greek myths were also translated to the Christian saints' legends, and we have in the latter stories of wonderful deliverances of God-beloved persons, like those which had so often appeared in the Hellenic epics of a thousand years before; and the dolphin thus found its way into the ancient Christian symbolism, where it figured as an emblem of love, of marriage-fidelity, and of the Christian; for it was regarded as a fish, and the fish was used (after the text in Matthew iv, 19, "I will make you fishers of men") to designate souls gained by baptism or conversion. Therefore it is often found on baptismal basins, and on grave-stones in the catacombs to indicate that the person resting there was a Christian; and it occurs, with an anchor, on the lids of Christian coffins. This curious and peculiar symbolism is less wonderful when we reflect that ancient Christian art was wont, in its dread of anthropomorphism, to betake itself to zoömorphism, and that it represented Christ himself by a fish. In the Belgian legends, the largest fish of the country, the sturgeon, figures instead of the dolphin as the deliverer and leader, and carries St. Amalberga over the Thames when she wishes to go to a cloister. In the German legend, Notburga is assisted across the Neckar by a stag.

These considerations will help to explain much that is mysterious in myth, legend, and art, in reference to the dolphin. It is quite obvious also that ancient artists prized this animal the more because it belonged to the beautiful forms of nature. The graceful lines of its body, contrasted with the relatively monotonous outlines of the fishes, commended it to their regard, and were appreciated by artists on account of the animation which the animal's movements in the water imparted

to them. Nevertheless, a comparison of the picture of a real dolphin with an ideal dolphin will show that a bare naturalism could have made much less than art has made out of the animal. But the ancient artists treated the animal world with great freedom, and a large appreciation of its spirit; they only made the real form prominent and mingled the unreal with it, or threw it entirely away, and thus by skillful treatment made a picture agreeable to the eye. This freedom was more justifiable, because the Greeks never had a particular species of dolphin in view; but, as Cuvier has shown, confounded with it the smaller sharks, thus inventing the extreme diversity of forms in which dolphins are depicted. Add to this the unstable element of the water in which the dolphin was always seen sporting, and the impossibility of getting an accurate view of its form under the circumstances, and it is evident that an artistic fancy might readily and legitimately exaggerate the proper form into the most grotesque. It would, of course, be natural for art to represent the animal as always in motion, and its tail with its sickle-shaped fins in the air after the manner in which it always showed itself to the sailors who observed it.—*Die Natur.*

THE PARENTAL FORESIGHT OF INSECTS.

IN no manner is the mysterious influence of instinct over the insect world more remarkably manifested than by the care taken by parent insects for the future welfare of offspring which they are destined never to behold. As the human parent upon his death-bed makes the best provision he can for the sustenance and prosperity of his infant children, whom death has decreed that he may not in person watch over, so those insects which Nature has decreed shall be always the parents of orphan children, led by an unerring influence within, do their best to provide for the wants of the coming generation.

The butterfly, after flitting through her short life, seeks out a spot whereon to deposit her numerous eggs, not—as one might expect of a creature devoid of mind—upon any chance plant, or even upon the plant or flower from which she herself has been wont to draw her sustenance, but upon the particular plant which forms the invariable food of the larvæ of her species. The various kinds of clothes-moths penetrate into our cupboards, drawers, and everywhere where furs, woolen garments, etc., are stored, that they may there lay their eggs, to hatch into the burrowing grubs which are the terror of our housekeepers. The ichneumon tribe, one of Nature's greatest counterpoises to keep down the too rapid increase of the insect world, lay their eggs in the larvæ of other insects, which eggs when hatched develop into a devouring brood, which ungratefully turn upon and devour the helpless creature that sheltered them as a nest. The female ichneumon

having discovered a caterpillar or grub which her instinct informs her has not been previously attacked, at once proceeds to thrust her ovipositor into the writhing body of her victim, depositing one or more eggs, according to the size of the living food-supply. When hatched, the larvæ devour and live upon their foster-parent, avoiding in a marvelous way the vital parts of their victim, whose life is most accurately timed to last until its young tormentors are full grown, and not beyond. At one time, we were led to believe in occasional instances of the instinct of female ichneumons being at fault, by observing them apparently ovipositing upon the dry shells of pupæ from which the butterflies had escaped. This, however, we subsequently found to be an erroneous idea, the fact of the matter being that the caterpillar upon which the parent ichneumon had laid her fatal egg had had time, before the full development of the young ichneumon grub, to turn to the pupal stage. What, then, we saw was the young ichneumon-fly just emerged from the dry pupal case, the contents of which it had first devoured in its own larval stage, then, itself turning to a pupa, it had lain, thus doubly incased, until, having broken forth a perfect fly, it rested upon its late prison, awaiting sufficient strength to come to its wings. What a wooden horse of Troy such a chrysalis would prove, if introduced into the breeding establishment of a collector!

Other members of the ichneumon tribe do not actually insert their eggs into the destined food-supply of their young; but, as it were, going deeper into calculation of future events, content themselves with laying them in close proximity to the eggs of some member of the tribe upon which it is their mission to prey.

There is an old saying:

> "Big fleas have little fleas
>   Upon their backs to bite 'em;
> Little fleas have smaller fleas,
>   So on *ad infinitum*"—

which is very true, inasmuch as from the great humble-bee down to the tiniest corn-thrips—a mere speck of dust to the naked eye—all insects have their parasites, and generally their own special species of ichneumon, to prevent their over-increase and to preserve the due balance of nature. There is a species of longicorn beetle, found in Pennsylvania, which feeds upon the tender bark of young hickory-shoots. When laying-time arrives, the female, having deposited her eggs in cavities perforated in the bark, carefully cuts a groove, about one-tenth of an inch wide and deep, round the shoot just below where her treasures lie. The object, or rather we suppose we ought to say the consequence, of this act is the withering and decay of the shoot, a provision for the sustenance of her young, which, when in their larval state, live upon dead wood! This remarkable insect is called the hickory-girder from the above-mentioned habit, which, we think, is one

of the most extraordinary instances of foresight, through a mere blind instinct, that have ever come under observation.

The gadfly (*Œustrus equi*), whose larvæ are the bots which inhabit the intestines of the horse, gains for her progeny that comfortable position by entrapping the animal itself into introducing her eggs within its stomach. For this purpose, she lays her eggs upon such portions of the horse's body as he is in the habit of frequently licking, such as knees, shoulders, etc. The unerring nature of her instinct is shown by the fact that she never chooses as a nidus any portion of the body which the horse is unable to reach with its tongue. Having thus been introduced into their natural feeding-grounds, the bots there pass their larval existence, until, it becoming time for them to assume the pupal form, they go forth with the animal's dung to reach the earth, burrow into it, and therein pass the insects' purgatory.

Again, one of the grain-moths (*Gelechia cerealella*) shows remarkable instinct in adapting itself to circumstances according to the time of year when it has to deposit its eggs. The first generation of these moths, emerging in May from pupæ which have lain in the granaries through the winter, lay their countless eggs upon the as yet ungathered corn, upon which their young play havoc until, having passed through the necessary stages, they come out in the autumn as the second generation amid the now stored-up grain. Now, however, their instinct prompts them, not, like the first generation, to go forth to the fields to seek the proper nest and future nourishment of their young, but bids them deposit their eggs upon the store of wheat ready at hand. Thus, two following generations of the same insect are led by their instincts to different habits to suit the altered and, in the last case, unnatural position of their infants' destined food-supply.

The interesting mason-wasp, having with great care and skill bored out a cylindrical hole in some sunny sand-bank, deposits at the bottom of this refuge her eggs. Next, provident mother as she is, she seeks out about a dozen small caterpillars, always of the same species, and immures them alive in the pit, as food for her cruel children. In making her selection of grubs to be thus buried alive, she rejects any that may not have reached maturity; not, we imagine, upon the score of their not being so full-flavored, but because, when not full-grown, they require food to keep them alive; whereas, when of mature age, they will live a long time without nourishment, ready to turn to chrysalides when opportunity occurs.

These are but a few of the instances which might be adduced in illustration of this foresight in insects, which compensates for their not being allowed in person to superintend the welfare of their offspring. In many cases, it would be better for human progeny were their parents thus endowed with an unerring instinct, rather than with an uncertain will.—*Chambers's Journal.*

SKETCH OF M. DE QUATREFAGES.

JEAN LOUIS ARMAND DE QUATREFAGES DE BRÉAU was born at Berthezeme, near Villerauge (Gard), France, February 10, 1810. His family was of the Protestant faith, and allied to the family of the publicist La Baumelle. His father was an educated agriculturist, who had served with distinction in Holland previous to the Revolution, but had returned to France on the breaking out of war between the two countries. Having received careful elementary instruction, young Quatrefages entered the medical course at Strasbourg, where he received the double diploma of Doctor of Medicine and Doctor in Science. On November 29, 1829, he sustained a thesis on the "Theory of a Cannon-Shot"; the next year he published at Strasbourg a work on aërolitlis; and in 1832 a medical thesis on "Extraversion of the Bladder." He was appointed an examination preparator of chemistry to the Faculty of Medicine at Strasbourg; and at a later period established himself at Toulouse, where he brought the study of the natural sciences and medical practice to the front, and published a number of articles in the "Journal of Medicine and Surgery" of Toulouse, and memoirs in the "Annals of the Natural Sciences" from 1834 to 1836. His essay on the "Axodontes," published in 1835, was the subject of a favorable report by a Commission of the Academy of Sciences, and attracted attention to his capacity as a naturalist. At the end of 1838, M. de Quatrefages was called on the nomination of M. de Salvandy, then minister, to the chair of Zoölogy in the Scientific Faculty of Toulouse; but that provincial town not offering the conveniences he desired for pursuing the researches on which he had become engaged, he resigned his position there in a short time and went to reside in Paris, where he enjoyed the friendship and had the assistance of M. Milne-Edwards, and, supporting himself by means of his books and the scientific articles he wrote for the periodical press, was able to pursue his studies with ardor and to publish the results of them.

In 1850, he was appointed Professor of Natural History in the Lycée Napoléon. In April, 1852, he was elected a member, in the Zoölogical Section of the Academy of Sciences, where he took the place of Savigny. In August, 1855, he was called to the chair of Anthropology and Ethnology in the Museum of Natural History; and it is in these fields of science that the work by which he is most distinguished has been performed.

In 1872 M. de Quatrefages participated in the organization of the French Association for the Promotion of Science which that year held its first meeting at Bordeaux, and in the absence of the designated president, Claude Bernard, who was prevented by the state of his health from attending, served as acting president. His opening ad-

dress is described in "Nature" as having been "a very stirring and noble one, full of sound sense as to the recent humiliation and present condition of France, enthusiasm toward science, and faith in it as one of the most powerful regenerators of the country. "Science is at present supreme," he said; "she is becoming more and more the sovereign of the world." And he believed that it would be only when all ranks and classes of the people, rulers and ruled, were thoroughly imbued with the scientific spirit and were guided by scentific knowlledge that France would ever again take and maintain the supreme place in the world which she ought to hold.

At the second meeting of this Association, held in August, 1873, at Lyons, M. de Quatrefages was president. In his opening address he pointed out the almost inconceivable advance that science had made during the past century, and the importance of scientific education. In speaking of the latter subject, he said that the devotees of literature accused Science of stifling the imagination. "'She kills,' they say, 'the ideal, and stunts intelligence by imprisoning it within the limits of reality; she is incompatible with poetry.' The men who speak thus have never read Kepler the astronomer, Linnæus the naturalist, Buffon the zoölogist, Humboldt the universal *savant*. What! Science stifle sentiment, imagination, she who brings us every hour into the presence of wonders! She lower intelligence, who touches on all the infinities! When literary students and poets know Science better, they will come and draw from her living fountain. Like Byron of our time, like Homer of yore, they will borrow from her striking imagery descriptions whose grandeur will be doubled by their truth. Homer was a *savant* for his time. He knew the geography, the anatomy of his era; we find in his verses the names of islands and capes, technical terms like *clavicle* and *scapula*. None the less, he wrote the 'Iliad.' No, the study of science will never suppress the genius of an inspired poet, of a true painter, of a great sculptor. But she will bring more light to the path of an erring soul. She will, perhaps, transform into a wise man, or at least into a citizen useful to himself and others, one who without her would only have been one of those pretended incomprehensible geniuses, designed to perish of misery, of impotency, and of pride. While fully admitting the important place of literature in education, he would wish to see children initiated at an early age into the facts, the ideas, and the methods of science.

"Governments, such as they have hitherto been, have almost always acted as if they had no need for the men who study Nature and her forces. But when any critical or important event occurs, then it is found necessary to appeal to them. Of whom are the juries of international exhibitions composed? No doubt each state sends its worthy merchants, its tried chiefs of industry, its eminent agriculturists, but it also, and above all, sends its men of science. At these important times peoples are comparing their real strength, and each feels that

it is for its honor in the present and its prospects in the future that the truth should appear; and to enlighten them, whether it be concerning cannons or silk-manufactures, telescopes or crystals, jewelry or hardware, it is felt that science is indispensable, and men of science are appealed to."

Beginning with 1842, M. de Quatrefages made a number of scientific voyages along the coasts of the ocean and the Mediterranean Sea, and in Italy and Sicily, which furnished him with the materials for a series of brilliant articles in the "Revue des Deux Mondes," some of which were afterward published (1854) in a volume entitled "Souvenirs d'un Naturaliste" ("Recollections of a Naturalist"). This was published in London in 1857 as "Rambles of a Naturalist on the Coasts of France, Spain, and Sicily." Among other works which he has published on subjects of general zoölogy are, translating the titles: "Considerations on the Zoölogical Characteristics of the Rodents" (1840); "On the Organization of the Invertebrate Animals of the Coasts of the British Channel" (in the "Annales des Sciences Naturelles," 1844); "Researches on the Nervous System, the Embryogeny, the Sensory Organs, and the Circulation of the Annelids" (ibid., 1844–1850); "On the Affinities and the Analogies of Earth-Worms and Leeches" (ibid., 1852); "On the Natural History of the Teredos" (ibid., 1848 and 1849). Invited by the Academy of Sciences to investigate the silk-worm disease, he published in 1859 "Studies," and in 1860 "New Researches on the Present Diseases of Silk-Worms." "Natural History of Marine and Fresh-Water Annelids" (1866); and "La Rochelle and its Environs" (1876). The later studies of M. de Quatrefages have been more predominantly in the direction of anthropology; and it is as an anthropologist that he is best known. In "The Human Species," which appeared in 1879, he took distinct ground in favor of the unity of the race.

The question whether there exists a fundamental distinction between man and animals he answered in the affirmative, and justified his position by the three considerations that man has the perception of moral good and evil, independently of all physical welfare and suffering; that man believes in superior beings who can exercise an influence over his destiny; and that he believes in the prolongation of his existence after this life. The author's idea of the moral and religious quality in man is conveyed in the sentence, "The learned mathematician, who seeks by the aid of the most profound abstractions the solution of some great problem, is completely without the moral or religious sphere into which, on the contrary, the ignorant, simple-minded man enters when he struggles, suffers, or dies for justice or for his faith." The different colors of men are regarded as results of accidental variations. Concerning the origin of the human species, M. de Quatrefages does not hesitate to reply in the negative to the question whether it is possible to explain the appearance on our globe of a being "which

forms a kingdom to itself." Concerning his attitude on this and kindred subjects, Mr. W. L. Distant remarks, in "Nature," that "it is to be noted how such an eminent naturalist as our author is still opposed to Darwinism, which in this section receives copious treatment, and some of the grounds principally given for its rejection are to many minds who embrace it the reasons of their faith." In treating of the psychological characteristics of the human species, M. de Quatrefages combats some of the views advanced by Sir John Lubbock, and criticises the common disposition to regard all sense of honesty as absent in certain races, as assuming too much on insufficient data. He says, on this point: "Nothing is more common than to hear travelers accuse entire races of an incorrigible propensity for theft. The insular populations of the South Seas have, among others, been reproached with it. These people, it is indignantly affirmed, stole even the nails of the ships! But these nails were *iron*, and in these islands, which are devoid of metal, a little iron was, with good cause, regarded as a treasure. Now, I ask any of my readers, supposing a ship with sheaths ing and bolts of gold, and nails of diamonds and rubies, were to sail into any European port, would its sheathing or its nails be safe?" In a paper on "The Crossing of the Human Races," which was published in "The Popular Science Monthly" for June, 1880, M. de Quatrefages took distinct ground, in opposition to the views of most of his fellow-anthropologists, that mixture of stocks, where the environment is favorable to its full operation and development, is for good. But he bears in mind that "the aggregation of physical conditions does not in itself alone constitute the environment. Social and moral condition-have an equal part in it." If real marriages take place between the races, he adds, and their offspring are placed upon a footing of equality with the mass of the population, "they are quite able to reach the general level, and sometimes to display superior qualities. All of my studies on this question have brought me to the conclusion that the mixture of races has in the past had a great part in the constitution of a large number of actual populations. It is also clear to me that its part in the future will not be less considerable. . . . The people of mixed blood already constitute a considerable part of the population of certain states, and their number is large enough to entitle them to be taken notice of in the population of the whole world." He concludes this paper with the obervation that the facts cited in it show that man is everywhere the same, and that his passions and instincts are independent of the differences that distinguish the human groups.

Other works of M. de Quatrefages are: "Comparative Physiology; Metamorphoses of Man and Animals" (1862); "The Polynesians and their Migrations" (1860); "Report on the Progress of Anthropology" (1867); "Darwin and his French Precursors" (1870); "The Prussian Race" (1871); and "Crania Ethnica," an important work prepared by him in connection with M. Hamy.

EDITOR'S TABLE.

THE BAD LOGIC OF MATERIALISM.

IN a preceding article we used the expression, "healthy materialism," for that view of things which frankly recognizes and makes practical allowance for the dependence of psychical phenomena upon material conditions, without undertaking in the least to decide the question as to the relations ultimately existing between mind and matter. This view we represented as at once conservative and progressive: conservative, in the limits which it recognizes as set to intellectual activity and in the prudence it enjoins in regard to all intellectual operations; progressive, in the aid which it affords toward securing the proper material basis for all intellectual and moral effort, and in the economy of labor which thence results.

This is not the materialism, however, against which the world has so strong a prejudice. The greatest sticklers to-day for a spiritualistic philosophy would make no objection to acknowledging the facts on which materialism, in the sense above described, is founded—that health of body is, other things being equal, the best condition for health of mind; that a certain relation must be observed between physical nutrition and repair on the one hand and intellectual effort on the other; that the quality, both of thought and of feeling, depends largely on the condition of the physical functions, and so on. No, these truths have been too much ignored in the past, but they are widely advocated to-day by teachers of unblemished orthodoxy; nevertheless, a strong feeling against what is called "materialism" survives. The common feeling on the subject is that materialistic theories tend to rob human life of a certain dignity, to undo something that the ages have wrought. Men seem to exclaim, in the words of Shelley:

> ". . . What can they avail?
> They cast on all things surest, brightest, best,
> Doubt, insecurity, astonishment."

The explanation and, as we think, the justification of this feeling lies in the fact that materialism as held, and more or less blatantly professed, by many, is in effect an attempt to explain higher orders of phenomena by lower, to ignore the complexities of existence, and to reduce everything to a kind of mechanical basis. Starting from the assumption that matter is not only the cause of everything, but is everything, they proceed to interpret matter according to the lowest and simplest properties it manifests. They want what Mr. Stallo calls a mechanical explanation of the universe; but, not content with that, they strive as much as possible to blind themselves to the fact that, while mechanical relations may lie at the basis of all things, in the actual evolution of the universe, relations of a much higher and more complex order have been established. We have heard men argue thus: "Matter is everything and everything is matter; morality can not inhere in or be any property of matter, therefore morality is an illusion, a prejudice, a superstition." Exception might of course be taken here to the major premise that matter is everything; matter, according to Mr. Spencer, not to mention less advanced thinkers, being simply one mode of the manifestation of the Unknowable Cause of all things. But, waiving this objection, and meeting the materialist on his own ground, we might say: "You affirm that matter is coextensive with existence, that whatever we have any knowledge of is some form

of matter. Excellent! A good way, therefore, to get as comprehensive and adequate an idea as possible of what matter is, would be to consider it in all its forms; in other words, to consider its total outcome. Among the realities of existence, nothing is more real than thought and emotion. We must, therefore, make provision for these in our conception of matter. But thought and emotion give rise to morality; and, if matter is to include everything, then must we concede to it a certain moral element. Matter, therefore, is something which not only contains 'the promise and potency' of every kind of human excellence, but which manifests itself in the highest phenomena of human life just as distinctly as in the laws of mechanics and physics. Our conception of matter is thus made to embrace and embody all that before had been divided between mind and matter. We can no longer, therefore, view matter as something essentially limited to lower and simpler manifestations. Our conception of it is enlarged and dignified just in proportion to what we have made it absorb. It is not apparent, therefore, that any dignity or value which before had attached to man's mental and moral life is in any way impaired by your representation of it as a function of matter. You have simply by your definition raised matter to a level with the highest phenomena of the universe, and stamped it with the character of equivalence with those phenomena. We may not accept your metaphysics, but we do not think they touch the essential dignity of those parts of human life which, perhaps, it was your intention to degrade in our estimation."

The trouble with "materialists" of a certain stamp lies precisely here: they think that by proclaiming the universality of matter they can bring everything down to the level of the lowest, i. e., the simplest, phenomena that matter displays; that they can dethrone love, rob honor of its luster, and virtue of its bloom. They say: Everything is matter, and matter should be interpreted in its lowest terms—in terms, say, of mechanics. But, if any partial interpretation is to be adopted, why interpret matter in its lowest rather than in its highest terms? As well ignore the laws of mechanics and physics and chemistry as the laws of mind, the laws of morality, the laws of society. "Materialism," in the sense indicated, is simply a willful tearing down of what nature has set up. In the realm of Nature, including the life of man, we discover an ascending series of laws and relations. The simplest and most universal relations are those of space and number. Above these, in complexity and speciality, are those of physics; above these, again, those of chemistry. And so we pass on to biology, psychology, and sociology. It would be the merest folly to take one's stand, say, on the laws of mathematics or mechanics, and to refuse to recognize any higher speciality or complexity in phenomena than these will account for. It would be folly for the chemist to refuse to hear of a science of physiology, simply because the problems and methods of physiology transcended those of his own science. It would be folly of the same kind for the physiologist to insist that his methods were adequate to the solution of all questions in psychology and ethics; or, on the other hand, to deny the validity of the methods employed in the latter sciences because they were not identical with those with which he was most familiar. We can conceive that, at the moment of the first formation of every higher science, there might be those who, in the supposed interest of established methods and canons, would call in question the phenomena upon which the new science was being constructed, or deny their special character. This would be "materialism" according to the conception of it here put forward—i. e., *an insist-*

ing on the interpretation of phenomena in lower terms than are suited to their special character. "Materialism" in this sense stands in the way of scientific progress, for, while the Newtonian maxim, "*Hypotheses non fingendæ sunt præter necessitatem*" (hypotheses are not to be framed beyond our actual need for them), is a very valuable one, the whole life of science is bound up in the liberty to frame hypotheses *according to* our needs.

We are perhaps now in a position to understand why materialism, in one phase at least, has excited so much suspicion and aversion. The conservative and the progressive instincts of mankind are at once against it. Men do not wish to be argued out of their perceptions of beauty, or out of their admiration for the higher human sentiments and virtues. But they would be argued out of everything of the kind, if they once consented to the principle that the true expression for any given phenomenon is the lowest that it admits of. "Tell love it is but lust!" says Sir Walter Raleigh, or whoever was the author of that pessimistic poem, "The Lie," which has sometimes passed under Raleigh's name. Such is the inspiring message which the materialism we are now considering sometimes feels called upon to deliver to the world. Sexual attraction is the physical basis of love; *ergo*, all love must be mere physical appetite. But the world knows that upon that basis great and glorious things have been built, and that love in its higher forms bears about as close a resemblance to lust as the perfect flower does to the soil from which it springs, or the seed in which it once lay imprisoned. The reasonable request of decent people is that things be left as God or Nature has arranged them; that what has been raised, by no act of man's, into beauty and honor, should hold its status unassailed by the destructive hands of sophistical levelers. Teach us the truth, they say; show us the unity of Nature; show us the analogies of type and function that proclaim and illustrate that unity; but do not seek to promote a morbid confluence of all the elements of thought by trying to make us think in the same terms of the most diverse facts. It is in its character of the universal denier that materialism encounters such hostility. It does not want to recognize the accomplished facts of Nature in any region higher than the lowest. But the facts survive, and will survive, all attempts to deny their existence. Man has come, and man is an intellectual and moral being. This is the great, irreversible fact which gives the lie to all pessimistic theories, and which renders nugatory all attempts to see nothing in the universe but matter and motion.

THE CONFLICT OF LANGUAGE-STUDIES.

That able quarterly, the "Bibliotheca Sacra," contains an article in its January issue which, considering the scholarly traditions of this old and high-toned periodical, is significant of wholesome progress. It is a defense of the claims of modern languages as against the ancient in the curriculums of college-study. The paper is entitled "A Plea for a Liberal Education," and is by James King Newton, Professor of the German and French Languages and Literature at Oberlin. For the benefit of such of our readers as may be interested in this important question, we present some of the considerations urged by this independent writer.

The ground taken by Professor Newton is substantially that which we have maintained throughout in "The Popular Science Monthly." Of course, he will be at once ranked, as we have been, among the enemies of the classics—a proceeding entirely without justification. He simply but firmly contends for the educational rights of German and French, as against the arrogant and extravagant pretensions put forward by

the Greek and Latin. He neither denies the value or importance of the classical languages, nor contemplates their exclusion from the college curriculum; but he condemns the vicious educational theories that have been put forward to vindicate and maintain their overshadowing supremacy. He is not an enemy of the classical languages, who opposes them as mere blindly venerated superstitions; but he, on the contrary, is their best friend, who would reduce them from this injurious pre-eminence, and leave them to stand on their merits for what they are worth. As important parts of learning to those who devote themselves to scholarship, or as interesting subjects to those who are attracted by their tastes to pursue them, or as badges of distinction in culture to those who prize them for such a purpose, or as bread-and-butter studies for the clerical profession, the dead languages have their defensible uses; but as a superior means of training the human mind, to be forced on everybody who goes to college and aspires to a liberal education, and as, consequently, disparaging other subjects, and standing in the way of far more important knowledge, they are to be resisted and reprobated as of evil influence by every friend of sound and rational education.

In the progress of the modern classical controversy, the practical issue has been most sharply made between the Greek and the German, and this is the issue to which Professor Newton's paper is mainly devoted, although it takes up various collateral points. He says:

Almost without exception in this discussion, the Greek has counted itself, and been counted by its opponents, on the side of the abstract, the disciplinary; while the modern languages have ranged themselves, or been ranged by their opponents, upon the side of the practical merely; grouped in with the sciences as useful knowledge, but lacking all, or nearly all, disciplinary value. But there are not a few fallacies which place the modern languages in opposition to the ancient, that need to be exposed, in order that, in the scheme of a liberal modern education, they may secure their proper time and place. It can easily be shown that many of the arguments used in favor of Greek as against German, both as to discipline and culture, are as true of the German as of the Greek.

Professor Newton then takes up the question of the alleged superiority of the Greek over the German in cultivating the attention and training the memory, and thoroughly exposes the fallacy of the claim. In regard to the processes involved in the exercise of translation, he says:

I believe it can be shown that the power of analysis and the power of synthesis are as much needed, and as much cultivated, by a thorough mastery of the German as of the Greek. For what is translation as a mental process? It is necessary, in the first place, that the mind grasp a thought expressed in words whose relations are shown by terminations, or by order of arrangement, or by particles; by any one, or by all three of these. Then, in the second place, this thought must be wrought over in the mind, fused, and poured out again into the molds or forms of the language into which one is translating, in strict accordance with its vocabulary, its idiom, and its spirit. And the same use of the same faculties is required in every possible translation. But the facility acquired by long practice in translating from one language must not be compared with the stumbling efforts of a beginner in translating from another. Of course, the same proficiency in translating can not be gained in three terms of German as in twelve terms of Greek. And it is not knowing German to be able to work one's way through a foot-note, and just miss the point from not knowing the force of a modal auxiliary.

For various cogent criticisms made by Professor Newton on the alleged superiority of Greek for general disciplinary effect we have no space to speak, but must reproduce what he says about the study of English:

In all these later arguments in regard to the disciplinary efficiency of the Greek there is the insinuation, or the explicit statement, that all modern languages, the English especially, are worthless, or worse than worthless, for purposes of discipline. A writer in the "Atlantic Monthly" for January, 1884, has

much to say on this subject, which has been more clearly said elsewhere; but he says plainly this one thing, which is often only hinted at or taken for granted: "The modern languages do not contain material out of which to construct a logical grammar like theirs" (the ancient languages). "What does English, French, or German grammar amount to? Simply *débris* of the classical languages, mixed with barbaric elements."

If this be true, we had better give up the study of Greek, and emulate the method of the Greeks, who made their language what it is by studying the Greek alone. They wrought upon it till it served their nicest uses. If our English be but a mixture of "*débris*" and "barbaric elements," it is high time for us to leave off studying other languages, both dead and living, and work upon our own until we make it somewhere nearly equal, as a thought-conveying medium, to the languages from which we are compelled to translate; for it is intellectual suicide to translate from a fine language into an incompetent one.

But this statement in regard to the English is not only not just, it is utterly false and misleading. We do, indeed, need to go to work upon it to realize what an incomparable language we have. Hear Jacob Grimm, prince among philologists:

No one of all the modern languages has acquired a greater force and strength than the English, through the derangement and relinquishment of its ancient laws of sound. The unteachable (nevertheless learnable) profusion of its middle-tones has conferred upon it an intrinsic power of expression, such as no other human tongue ever possessed. Its entire, thoroughly intellectual, and wonderfully successful foundation and perfected development issued from a marvelous union of the two noblest tongues of Europe, the Germanic and the Romanic. Their mutual relation in the English language is well known, since the former furnished chiefly the material basis, while the latter added the intellectual conceptions. The English language, by and through which the greatest and most eminent poet of modern times—as contrasted with ancient classical poetry—(of course I can refer only to Shakespeare) was begotten and nourished, has a just claim to be called a language of the world; and it appears to be destined, like the English race, to a higher and broader sway in all quarters of the earth. For in richness, in compact adjustment of parts, and in pure intelligence, none of the living languages can be compared with it—not even our German, which is divided even as we are divided, and which must cast off many imperfections before it can boldly enter on its career.

Yet, while foreigners are writing thus of our language, we are telling each other and our students—who happily do not always believe us—"that the Greek is more perfect; that the Latin is more polished; that the German is stronger; that the French and Italian are more musical; and we seem to be studying other languages, not to train ourselves to see and use the beauty and strength of our own, but only to cultivate a contempt for it.

Pursuing this idea of the claims of modern languages, Professor Newton quotes various authorities as to the great philological importance of their more systematic study, and he gives a strong passage from Max Müller in which it is declared that "before the tribunal of the science of language the difference between ancient and modern languages vanishes. . . . Where, except in these modern dialects, can we expect to find a perfectly certain standard by which to measure the possible changes which words may undergo, both in form and meaning, without losing their identity? . . . where, again, except in the modern languages, can we watch the secret growth of new forms, and so understand the resources which are given for the formation of the grammatical articulation of language?" Professor Newton says: "I have brought forward these arguments to show that there are reasons to be adduced for studying the modern languages, other than that they are so 'easy'; that there are reasons *per se;* and that in every college for either drill or culture the modern languages should have a respectable space and a respectful recognition. As it is now, every young man who elects the one term of French, or even the three terms of German, must count over against their being 'easy' the popular estimation that they are 'boarding-school' studies."

Professor Newton is of opinion that the tenacious adherence to classical traditions in regard to the study of lan-

guage is certain to prove injurious if not disastrous to our American colleges. Progress of knowledge, the spirit of the age, and the requirements of the American people must count for more than has been yielded to them if these institutions are to increase in influence and prosperity. He says:

The demands of our own polyglot people are to be heard, if we wish them to come to school. If we of the colleges decide that we wish no one to come but those who will take the one old road, the numbers in the colleges will not greatly increase, even though the population of our country quadruples. For we must judge of the future by the past in this matter. The population of the United States, as shown by the census, increased during the ten years, between 1870 and 1880, from thirty-eight and one half millions to fifty millions—an increase of twenty-three per cent. But the increase in number of students, for the same time, in twenty of the oldest, leading colleges, was less than three and one half per cent. Something is keeping the sons of our well-to-do common people out of the colleges. It is not the hard work. They work much harder on things that pay less in profit and position. It is not that they are not hungry for knowledge. They go greedily after husks even. But among the thousands of things they want to know and need to know, in order to have part in the life they are to lead, Greek seems to them of the least necessity. And it is because this bar of the Greek lies across the path to a college education that the crowd is turned from college halls. We of the cloisters may say, it should not seem of small importance to sensible people; but it does seem so. And we are causing thousands every year to lose all the rest of a college training, because we persist in making Greek the one, universal, inexorable test of admission to college.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, VOL. XLVIII.

Origin of Cultivated Plants. By Alphonse De Candolle. New York: D. Appleton & Co. Pp. 468. Price, $2.

Although a thoroughly popular work interesting to everybody, this volume is nevertheless a monument of laborious and learned research. Its author is not only one of the most eminent botanists of the age, but he has been for many years especially devoted to this subject. He published an extensive work thirty years ago on "Geographical Botany," one chapter of which was devoted to the "Origin of Cultivated Plants," and he has since pursued the subject so systematically and perseveringly that the field is now his own. The present book, however, is entirely new, and gives what is known of the history of nearly all plants which are cultivated, either on a large scale for economic purposes, or in fields, orchards, and kitchen-gardens.

The work, as may be supposed, has been one of very great difficulty. Lack of knowledge, doubtful statements, and, what is worse, long sanctioned and established error, have proved formidable difficulties in the way of research. Plants, like men, have not only traveled over the globe from region to region, undergoing changes in their migrations into new environments, but they have been directly modified by domestication, so that only thorough botanical knowledge can trace their lineage and throw light upon their origin. In some cases the original wild species are probably extinct, and in other cases the cultivated varieties have lapsed into the wild condition, so that the problem of identification is liable to be much obscured. But greater difficulties still have arisen from the fact that botany is a modern science of which the ancients knew very little, so that their descriptions are imperfect and untrustworthy. The embarrassments of the research are, moreover, heightened by that revolution in regard to the validity of evidence which science has wrought in recent times. All statements have to be questioned and sifted, and loose opinions thrown aside by the more exacting standards of proof which men of science now recognize. On these points, and with reference to the general plan of his inquiries, Professor De Candolle remarks:

I have always aimed at discovering the condition and the habitat of each species before it was cultivated. It was needful to this end to distinguish from among innumerable varieties that which should be regarded as the most ancient, and to find out from what quarter of the globe it came. The problem is more difficult than it appears at first sight. In the last century and up to the middle of the present, authors made little account of it, and the most able have contributed to the propagation of erroneous ideas. I believe that three out of four of Lin-

næus's indications of the original home of cultivated plants are incomplete or incorrect. His statements have since been repeated, and, in spite of what modern writers have proved touching several species, they are still repeated in periodicals and popular works. It is time that mistakes, which date in some cases from the Greeks and Romans, should be corrected. The actual condition of science allows of such correction, provided we rely upon evidence of varied character, of which some portion is quite recent, and even unpublished; and this evidence should be sifted as we sift evidence in historical research. It is one of the rare cases in which a science founded on observation should make use of testimonial proof. It will be seen that this method leads to satisfactory results, since I have been able to determine the origin of almost all the species, sometimes with absolute certainty, and sometimes with a high degree of probability.

The investigations of De Candolle assume a new and enlarged interest from the results of modern biological progress in regard to the transformations of species, and the vast periods of time during which organic development and mutations have been going forward. The great problem was fundamentally changed with the abandonment of the old view regarding the immutability of species. It was under the careful study of plants that that view first broke down, and from that time a radically new method has prevailed in the study of the vegetable kingdom. From this point of view the historical question of the origin of cultivated plants not only became a modern question, belonging, indeed, to the present age, and incapable of earlier solution, but it connects itself with vast periods of change, and is linked on to the largest considerations of the economy of life upon the earth. We quote some further instructive observations of our author in regard to important particulars of his research:

I have endeavored to establish the number of centuries or thousands of years during which each species has been in cultivation, and how its culture spread in different directions at successive epochs. A few plants cultivated for more than two thousand years, and even some others, are not now known in a spontaneous, that is, wild condition, or at any rate this condition is not proved. Questions of this nature are settled. They, like the distinction of species, require much research in books and herbaria. I have even been obliged to appeal to the courtesy of travelers or botanists in all parts of the world to obtain recent information. I shall mention these in each case, with the expression of my grateful thanks.

In spite of these records and of all my researches there still remain several species which are unknown wild. In the cases where these come from regions not completely explored by botanists, or where they belong to genera as yet insufficiently studied, there is hope that the wild plant may be one day discovered. But this hope is fallacious in the case of well-known species and countries. We are here led to form one of two hypotheses: either these plants have since history began so changed in form in their wild as well as in their cultivated condition that they are no longer recognized as belonging to the same species, or they are extinct species. The lentil, the chick-pea, probably no longer exist in nature; and other species, as wheat, maize, the broad bean, carthamine, very rarely found wild, appear to be in course of extinction. The number of cultivated plants with which I am here concerned being 249, the three, four, or five species, extinct or nearly extinct, is a large proportion, representing a thousand species out of the whole number of phanerogams. This destruction of forms must have taken place during the short period of a few hundred centuries, on continents where they might have spread, and under circumstances which are commonly considered unvarying. This shows how the history of cultivated plants is allied to the most important problems of the general history of organized beings.

From these considerations it will be seen that the present volume is of capital interest to all concerned with botanical science. It is an authoritative digest of facts to be nowhere else found, and has been executed with the strictest fidelity to the original sources of information. The fullness and minuteness of the references to works consulted greatly enhance the scientific value of the volume, and will undoubtedly be much appreciated by botanical students.

But, as we remarked at the outset, the book is entirely popular, and thoroughly intelligible to common readers. Its plan is simple. Part I consists of two chapters of general preliminary remarks as to I, "In what Manner and at what Epochs Cultivation began in Different Countries"; and II, "Methods for discovering or proving the Origin of Species." In Part II, the main portion of the work, the divisions are simple and practicable, as follows: I, "Plants cultivated for their Subterranean Parts, such as Roots, Tubercles, or Bulbs"; II, "Plants cultivated for their Stems or Leaves"; III, "Plants cultivated for their Flowers, or the Organs which envelop them"; IV, "Plants cultivated for their Fruits"; V, "Plants cultivated for their Seeds." At the close there is a valuable table summing up the general results, which is followed by a careful index. All the

plants described are given under their common names.

It would seem that all intelligent people should desire to be informed concerning the history of such familiar things as the plants that are used for daily food; but the intellectual interest of the subject is heightened when we find that this common subject is involved largely in the progress of human civilization.

The New Philosophy. By Albert W. Paine. Bangor, Me.: O. F. Knowles & Co. Pp. 168. Price, $1.

Mr. Paine in this book presents a new theory respecting the connection of the two worlds in which he believes man has his existence, and their intimate relations to each other, based on the psychical and so-called spiritual phenomena which have recently attracted attention. He supposes that man while an inhabitant of this world is composed of two factors, soul and body, each of which is complete in itself and separate from the other as regards constituent form, but corresponding with the other in all essential particulars, the body being permeated by the soul in every minutest part, and that the separation from each other is death, upon which the soul becomes wholly independent. He also proposes a theory of electricity, the essential feature of which is that that agent is closely related with the great law of spiritual existence.

Text-Book of Botany, Morphological and Physiological. By Julius Sachs, Professor of Botany in the University of Würzburg; edited, with an Appendix, by Sydney H. Vines, M. A., D. Sc., F. L. S., Fellow and Lecturer of Christ's College, Cambridge. Macmillan & Co. Second edition. Pp. 980. Price, $8.

We noticed this important work upon its first appearance, and recognized its position as foremost among the standard treatises on botanical science of the present day. The work is intended to put the student in full possession of the present state of knowledge upon the subject, and, besides describing the phenomena of plant life which are already accurately known, it indicates also very fully those theories and problems in which botanical research is at present especially engaged. Detailed discussions of questions of minor importance have been avoided, and the historical development of botanical views has also been omitted, that the entire space of the work may be devoted to a representation of the existing condition of the science.

No change in the plan of the work has been made in this new edition, nor any modification of its leading features. Some minor alterations and additions have been introduced, and something has been done to improve and perfect the translation. A few notes are appended to the volume, embodying some of the very latest results in botanical research. The work is elegant in form and complete in its treatment, and may be commended as the most adequate treatise for the thoroughgoing botanical student, and at the same time one of the best books we have for general reference in a library.

Rudimentary Society among Boys. By John Johnson, Jr. Baltimore: N. Murray. Pp. 56. Price, 50 cents.

In this paper the editor of the Johns Hopkins University "Studies in Historical and Political Science" has consented to include a plot a little outside of the field which it was first intended to cultivate in those studies, and he has decided wisely. The paper describes the spontaneous organization of a community, and the growth of laws and established customs among a group of boys just brought together, almost from the wild state, at the school with which he was connected; and gives a study, from actual contemporary observation, of the manner in which, in all likelihood, the primitive societies grew up and became fixed. The school was the McDonough School, near Baltimore, to which is attached a domain of eight hundred acres, giving ample privileges for nutting and bird's-nesting and rabbit-trapping. In the beginning everything was common. The first to grasp a prize secured it. All is very different now. Conflicts came, and made rules necessary to avoid them. The rules were made by the boys' own action, as occasion arose for forming them; and now the property and the privileges are all parceled out, with fixed regulations for their tenure, transference, and descent. Classes have grown up of landlords and tenants, and there are monopolists and persons

who have no estates. A system of credits has been developed, with something like banks. And the McDonough School has become the epitome of a State, with its laws, and its vested interests, and its business methods, all systematically regulated, and the regulations a living force. The successive steps that have led up to this condition, the reason for each new measure, and the effect of it after it went into operation, are graphically described in the essay.

Town and County Government in the English Colonies of North America. By Edward Channing, Ph. D. Baltimore: N. Murray. Pp. 57. Price, 50 cents.

This is another of that series of valuable studies in the development of our political history which the Johns Hopkins University is giving to the public in monthly monographs. It describes the manner in which the parochial, or town, and county organizations in the older colonies arose, from some or other of which the similar organizations of the newer States in their essential features were derived. The exact form which the local organization in each colony should assume is regarded as having depended upon the economic conditions of the colony; the experience in the management of local concerns which its founders brought from the mother-country; and the form of church government and local organization which was found expedient.

Prehistoric America. By the Marquis de Nadaillac. Translated by N. D'Anvers. Edited by W. H. Dall. New York: G. P. Putnam's Sons. Pp. 566, with 219 Illustrations. Price, $5.

The author of this work was already well known to students of archæology by the book previously published by him on primitive men and prehistoric times, in which were described the stone age of Europe and the early resting-places of the ancient inhabitants of the Old World. The good-will with which that work was received has led him to supplement it by tracing the analogous period in America. In carrying out this study, he has made good use of the investigations which have been undertaken in the United States, to which he fittingly acknowledges his obligations. As a result he has given a methodical and comprehensive treatise, constituting, perhaps, the most adequate presentation of the whole subject that has yet been made in a single volume. The present translation has been made with the author's sanction, and, with his permission, has been so modified and revised by the editor—who is recognized as an expert in this branch—as to bring it into harmony with the results of recent investigation and the conclusions of the best authorities on the archæology of the United States. In the final chapter the editor expresses his views as to the manner in which America was peopled, to the effect that it was done at different times by scions of different races. The completeness of the index deserves commendation.

The Eclectic Physiology. By Eli F. Brown, M. D. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 189, with Plates.

This is a treatise prepared with special reference to its use in schools, and giving only such matter as seems needful to enable pupils fairly to master the subject, but with supplementary matter in notes. The study is made to proceed from the simplest, in a plain order of dependence, to the most complex parts: under each topic, attention is first given to the structure and use of parts; upon which the hygiene of the part follows closely. Attention is given to the care of proper sanitary conditions in the home, and to the discussion of habits; and the effects of narcotics and stimulants on the body and mind are set forth plainly and fully.

Icaria: A Chapter in the History of Communism. By Albert Shaw, Ph. D. New York: G. P. Putnam's Sons. Pp. 219. Price, $1.

The purpose in this book is simply to present in full the history of a single communistic enterprise, without going into the discussion of the merits or demerits of communism, or into the consideration of any topic aside from the narrative. The author submits two particular reasons why this story should be told: First, it has never been told before, except in the most meager and inaccurate way, and is besides a peculiarly romantic and interesting one; second, because "as an example of communism in the concrete, Icaria has illustrative value

beyond all proportion to its wealth, membership, and success. Most of the communistic societies of the United States might better be studied as religious than as socialistic phenomena. . . . Icaria is an attempt to realize the rational, democratic communism of the Utopian philosophers, hence its value as an experiment."

The Elements of Chemistry, Inorganic and Organic. By Sidney A. Norton, Ph. D. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 504.

Intending his treatise to be used as a text-book, not as a manual for reference, Professor Norton has endeavored to select such chemical phenomena as represent the cardinal principles of the science, giving preference to those which are easily reproduced by the student, and which enter into the affairs of common life. He invites students to experiment, and encourages them, if they can not afford artistically made apparatus, to extemporize apparatus with bottles and tumblers and connecting tubes. The most essential thing in experimenting, he says, is the experimenter, who should know what he proposes to do, what are the means at his command, and how he intends to use them; and, chemistry being exact in its methods, he must remember that careless manipulation will not secure good results, and that such words as neutral, acid, basic, and excess, must not be neglected. In nomenclature, the rules of the London Chemical Society are observed; in notation, a flexible plan has been adopted; and, in the descriptions of elements, Mendelejeff and Meyer's classification has been followed.

Report of an Archæological Tour in Mexico, in 1881. By A. F. Bandelier. Boston: Cupples, Upham & Co. Pp. 326, with Twenty-six Plates.

The report is one of the papers of the Archæological Institute of America, in co-operation with which Mr. Bandelier made his explorations, and is the second of the American series of its special reports. Besides the notes of the explorer's travel, it embraces his studies of and observations upon the archæological relics in the city of Mexico, the mounds of Cholula, and the interesting ruins of Mitla, all richly illustrated, largely from photographs.

Science in Song; or, Nature in Numbers. By William C. Richards. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 131.

An attempt to present various facts and principles of science in verse. Among the special topics sung in measured numbers are steam, electricity, the spectroscope, magnetism, various chemical elements, heat, astronomical phenomena, etc. The verse has considerable life and merit as verse, and the author's success justifies his belief that philosophy and poetry in union are not incongruous. The singer's bias is decidedly against the doctrine of evolution, which he appears to believe — mistakenly, as both sides are coming to conclude—is in some way hostile to the foundations of his religious faith.

Reports of the Meetings of the Scientific Associations held in Montreal and Philadelphia, as given in "Science." Cambridge, Mass.: "Science" Company. Pp. 112.

Accounts of the proceedings of the recent meetings of the British and American Associations at Montreal and Philadelphia, with abstracts of the more important and interesting papers, including the presidential and vice-presidential addresses, were published in the consecutive numbers of "Science," from August 29 to October 3, 1884. These six numbers are here combined in a bound volume under the title given above, which, besides the abstracts mentioned, contains considerable other matter of scientific interest.

Representative British Orators, with Introductions and Explanatory Notes. By Charles Kendal Adams. New York: G. P. Putnam's Sons. Three volumes, pp. 318, 308, and 376. Price, $3.75.

The object of this publication is to help show the great currents of political thought that have shaped the history of Great Britain during the past two hundred and fifty years, by bringing together the most famous of those oratorical utterances that have changed, or have tended to change, the course of English history. While the orations included — from masters of English oratory—are great as rhetorical efforts, it is not for this that they are given, but for their political significance. Eliot and Pym

formulated the grievances against absolutism out of which the Parliamentary revolution grew; Chatham, Mansfield, and Burke had to do with the principles of the foundation of American independence; Mackintosh and Erskine championed the freedom of juries and of the press; Pitt expounded the policy of continuous opposition to Napoleon; Fox pleaded for peace; Canning inaugurated the English foreign policy; Macaulay cogently advocated the "Reform Bill" revolution; Cobden brought on the blessing of free trade. In our own generation, Bright denounced the foreign policy of the empire; Beaconsfield expounded the principles of the Conservatives; and Gladstone formulated, as he now conspicuously represents, the doctrines respecting home and foreign affairs of the Liberals. It is the speeches in which are clearly declared these several principles, and which "at one time or another have seemed to go forth as in some sense the authoritative messages of English history to mankind," that are here brought together.

An Elementary Treatise on Analytic Mechanics. By Edward A. Bowser, LL. D. New York: D. Van Nostrand. Pp. 511.

Professor Bowser's work is designed as a text-book for students of scientific schools and colleges who have received training in the elements of analytic geometry and the calculus. The analytic method has been chiefly employed, though geometric proofs have been introduced where such were deemed preferable. The book consists of three parts: Part I, with the exception of a preliminary chapter, is devoted to statics; Part II is occupied with kinematics; and Part III treats of the kinetics of a particle and of rigid bodies. For the attainment of that grasp of principles which it is the special aim of the book to impart, numerous examples are given at the ends of the chapters.

Elements of English Speech. By Isaac Bassett Choate. New York: D. Appleton & Co. Pp. 220. Price, $1.

Perhaps this book may be briefly described as a volume of essays on topics in the English language. The first four chapters are devoted to demonstratives, prepositions, connectives, and nouns, dealing with the functions of these parts of speech, and giving the histories of many words, with illustrative quotations from early English poems. The next four chapters deal with verbs and their conjugation. Certain causes of changes in pronunciation of the Latin and English languages are next considered, and the original meanings of some familiar words are shown.

T. Lucreti Cari de Rerum Natura (T. Lucretius Carus concerning the Nature of Things). With an Introduction and Notes. By Francis W. Kelsey. Boston: John Allyn. Pp. 385. Price, $1.75.

The entire poem of Lucretius is here published, in Latin, with explanatory notes on the first, third, and fifth books, which are chosen for comment because they contain the gist of the poet's doctrine and a greater number of fine passages than the others. An analysis of the subject-matter given in the introduction will facilitate the reading of the remaining books. Besides the notes and the analysis, the editor gives essays in the introduction on "Lucretius as a Man," "Lucretius as a Philosopher," and "Lucretius as a Poet." The second essay includes reviews of philosophy among the Romans in the poet's time, and of epicureanism up to his time, and as set forth by him.

Country Cousins: Short Studies in the Natural History of the United States. By Ernest Ingersoll. New York: Harper & Brothers. Pp. 252.

Many animal families are represented in these sketches of "Country Cousins"; the squirrel, shrew, elk, and a number of our birds are visited in their homes, and there is an account of "rattlesnakes in fact and fancy." A description is given of Professor Agassiz's sea-side laboratory on Penikese Island, which furnishes an introduction to several chapters on sea-creatures, including the life and tribulations of the oyster, and sketches of other mollusks, devil-fishes, and seals. There are also accounts of the caverns at Luray and at Pike's Peak, a chapter on the shell-money of the native Americans, and one on village naturalists' clubs. The volume is handsomely illustrated.

Land and its Rent. By Francis A. Walker, Ph. D., LL. D. Boston: Little, Brown & Co. Pp. 232. Price, 75 cents.

This volume contains the substance of four lectures delivered in Harvard University, in May, 1883. While the author differs from most American economists upon the relation of wages to the interest of capital and to the profits of business management, he claims to be, in his view of the origin of rent and its influence upon the distribution of wealth, "a Ricardian of the Ricardians." He first presents the economic doctrine of rent, and then considers attacks upon the doctrine by Bastiat, Carey, and Leroy-Beaulieu. He expresses a high opinion of Bastiat's noble purpose and able writing, but says that, "as a constructive economist, he made a dead failure, while his views regarding the land are especially erroneous." Attacks upon the practice of individual appropriation of land, by J. S. Mill and Henry George, are next examined, and the propositions of the latter are emphatically condemned. In the concluding chapter Dr. Walker offers some suggestions regarding that tenure of the land which is best suited to advance the interests of society as a whole.

Public Relief and Private Charity. "Questions of the Day," No. 13. By Josephine S. Lowell. New York: G. P. Putnam's Sons. Pp. 111. Price, paper, 40 cents.

Starting with the conviction that it is for the best interests of all that the indigent members of any civilized community be kept from desperation or death by the produce of those who work, the writer goes on to show that care within the walls of institutions is much more economical, and has a better moral effect, than out-door relief. Copious extracts from reports and addresses, testifying to the evil results of out-door relief practice in England, are given, and are supplemented by similar testimony from Continental and American observers. For each county three departments are recommended, namely: for the care of children, care of public dependents, and reduction of crime. Special attention is directed to the importance of removing children from the influence of vicious parents, and the labor-test as a preliminary to aiding able-bodied adults is insisted on.

The Human Body. By H. Newell Martin and Hetty Cary Martin. New York: Henry Holt & Co. Pp. 261, with Plates. Price, 90 cents.

This is a "beginner's text-book" in anatomy, physiology, and hygiene. It attempts to present accurately, and, at the same time, in such a way that children can understand them, those facts concerning the structure and actions of the living human body which it is desirable, for practical purposes, that every one should know. The broad facts of human anatomy and physiology are presented, but little more is introduced than is necessary to make clear the reasons, as regards the preservation of health, for following or avoiding certain courses of conduct. Prominence is given to matters which are usually within the easy control of each individual. The dangers attending the use of stimulants and narcotics are forcibly presented.

Bermuda: An Idyl of the Summer Islands. By Julia C. R. Dorr. New York: Charles Scribner's Sons. Pp. 148, with Maps. Price, $1.25.

The author spent a spring in Bermuda, and in this book records her experiences and observations in a pleasant and instructive manner. She gives personal adventure, geography, history, pictures of life and descriptions of scenery, character-sketches, and a little natural history, gossip, and useful information, judiciously proportioned and pleasantly mingled. These qualities make the work as good a guide as the visitor would wish to carry with him, or, if he does not wish to go, a most agreeable companion for his "fireside travel"—the imaginary journey he might take while sitting before his fireplace.

Vocal and Action Language. By E. N. Kirby. Boston: Lee & Shepard. Pp. 163. Price, $1.25.

Mr. Kirby's hand-book has grown up in the class-room, and is designed to supplement, not to supplant, the work of the teacher. He insists on physical training as one of the fundamentals of vocal culture, and gives descriptions of the respiratory and vocal organs, based upon Dr. Martin's "The Human Body," with cuts from that work. Vocal development, orthoepy, and

vocal expression, are considered successively, and then follows expression by action, not only by the arms, but also by the head, trunk, and legs. Some general directions for public speaking, and several selections, with the elocutionary analysis marked, are added.

PUBLICATIONS RECEIVED.

A Directory of Writers for the Literary Press in the United States. Compiled by W. M. Griswold, A. B. Bangor, Me.: Q. P. Index, publisher. 1884. Pp. 25. 50 cents.

"United States Publications. Monthly Catalogue." Vol. I, No. 1. January, 1885. J. H. Hickcox. Washington, D. C. Pp. 22. $2 a year.

Proceedings of the American Society of Microscopists. Seventh Annual Meeting. Buffalo: Bigelow Brothers, printers. 1884. Pp. 300.

Mind in Medicine, By Rev. Cyrus A. Bartol, New York: M. L. Holbrook, publisher. 1884.

Moeris. The Wonder of the World. By F. Cope Whitehouse, M. A. New York: John Wiley & Sons. 1885. Pp. 16. Illustrated.

"Bulletin of the New England Meteorological Society." Nos. 1 and 2. November and December, 1884.

Obstructions of the Gall-Duct, with Remedial Operation suggested. By J. McF. Gaston, M. D. Pp. 27.

"Journal of Mycology." W. A. Kellerman, Ph. D., Editor. Manhattan, Kansas. Vol. 1, No. 1. January, 1885. Monthly. Pp. 16. $1 a year.

Notes on the Progress of Mineralogy in 1884. By H. Carvill Lewis. Philadelphia. January, 1885.

Sunlight. Short Letters to the Editor of the Belfast "Northern Whig." By the author of "The Beginnings." Pp. 66.

Circulars of Information of the Bureau of Education. No. 6, 1884 Rural Schools. Washington: Government Printing-Office. 1884. Pp. 90.

Conspectus of the Medical Colleges of America. Sessions of 1884-'85. Illinois State Board of Health. Springfield, Ill. 1884. Pp. 96.

The Composition and Methods of Analysis of Human Milk. By Professor Albert R. Leeds, Ph. D. Pp. 27.

Quarterly Report of the Chief of the Bureau of Statistics for the Three Months ending September 30, 1884. Washington: Government Printing-Office. 1885. Pp. 249.

The Genesis of the Merrimack Valley. By Samuel D. Lord. Concord, N. H. 1885. Pp. 17.

The Fucoids of the Cincinnati Group. By Joseph F. James. Reprint from the "Journal of the Cincinnati Society of Natural History" for October, 1884, and January, 1885. Pp. 25. Illustrated.

"Journal of the New York Microscopical Society." Edited by Benjamin Braman. Vol. I, No. 1. January, 1885. New York. Pp. 32. Nine numbers to the year: subscription price, $1.

The Next Step of Progress: A Limitation of Wealth. By John H. Keyser. Pp. 50. Price 20 cents.

Notes on the Condition of Zoölogy Fifty Years ago and To-day. By Professor E. S. Morse. Salem, Mass. 1884. Pp. 9.

"The West-American Scientist." C. R. Orcutt, San Diego, Cal. Vol. I, No 2. January, 1885. Monthly. Pp. 8. 50 cents a year.

Christianity a Reward for Crime. By O B. Whitford, M. D. New York: The Truth-Seeker Company. 1885. Pp. 29.

Man in the Tertiaries. By Edward D. Cope. 1884. Pp. 15.

Report of the Executive Committee of the Niagara Falls Association. January, 1885. Pp. 43.

The Part of Jesus and of the Apostles. By Dr. G. M. Rabbinowicz. Translated from the French by Philip Zadig. San Francisco, Cal.: J. B. Golly & Co. 1884. Pp. 213.

Studies from the Biological Laboratory of Johns Hopkins University. Edited by H. Newell Martin and W. K. Brooks. Vol. III, No. 2. December, 1884. Baltimore: N. Murray. Pp. 70. 50 cents.

Fourth Annual Report of the Astronomer in charge of the Horological and Thermometric Bureaus of the Observatory of Yale College. 1883 and 1884. By Leonard Waldo. Pp. 13. And Report for the year 1883-'84 of the Board of Managers of the Observatory of Yale College. Pp. 19.

Maryland's Influence upon Land Cessions to the United States. By Herbert B. Adams. Part I; Third Series Johns Hopkins University Studies in Historical and Political Science. Baltimore, January, 1885. Pp. 101. 75 cents.

Heavy Ordnance for National Defense. By Lieutenant William H. Jaques. New York: G. P. Putnam's Sons. 1885. 25 cents.

Comparative Study of German. By William W. Valentine. Richmond, Va.

Annual Report of the Hydrographer to the Bureau of Navigation for the Year ending June 30, 1884. Washington: Government Printing-Office. 1884. Pp. 19.

Reports of Observations and Experiments in the Division of Entomology, United States Department of Agriculture. By C. V. Riley, Entomologist. Washington: Government Printing-Office. 1884. Pp. 102.

Steam-Boilers as Magazines of Explosive Energy. By Professor R. H. Thurston. 1884. Pp. 26.

Description of Carcharodon Carcharias. By W. G. Stephenson, M. D. Poughkeepsie, N. Y. 1884. Pp. 8. Illustrated.

On the Iron-Ores of the Juragua Hills, Santiago, Cuba. By James P. Kimball. 1884. Pp. 36, with Maps.

Note on a Peculiar Form of Pulmonary Congestion. By A. H. P. Leuf, M. D. 1885. Pp. 15.

Report on the Industrial, Social, and Economic Conditions of Pullman, Ill. By the Commissioners of the State Bureau of Labor Statistics. 1884. Pp. 27.

The Pororóca. By John C. Branner, B. S. Boston: Printed by Rand, Avery & Co. 1885. Pp. 12.

Notes on the Psychology of the Chimpanzee. By Dr. C. Pitfield Mitchell. 1885. Pp. 16.

The Distribution of Products. By Edward Atkinson. New York: G. P. Putnam's Sons. 1885. Pp. 300. $1.25.

Stories by American Authors. New York: Charles Scribner's Sons. 1885. Pp. 180. 50 cents.

A Popular Exposition of Electricity. By Rev. Martin S. Brennan. New York: D. Appleton & Co. 1885. Pp. 191. 75 cents.

The Wane of an Ideal. A Novel. By La Marchesa Colombi. From the Italian by Clara Bell. New York: W. S. Gottsberger. 1885. Pp. 260. 90 cents.

Shadows. By John Wetherbee. Boston: Colby & Rich. 1885. Pp. 287.

Geonomy. By J. Stanley Grimes. Philadelphia: J. B. Lippincott & Co. 1885. Pp. 116.

Egypt and Babylon. By George Rawlinson, M. A. New York: Charles Scribner's Sons. 1885. Pp. 329. $1.50.

One Hundred Years of Publishing—1785-1885. Philadelphia: Lea Brothers & Co. 1885. Pp. 20.

Annual Report of the Chief Signal Officer to the Secretary of War for the Year 1883. Washington: Government Printing-Office. 1884. Pp. 1,164.

Sixth Annual Report of the Illinois State Board of Health. Springfield, Ill. 1884. Pp. 324.

Memoir upon the Formation of a Deaf Variety of the Human Race. By Alexander Graham Bell. Pp. 86.

Researches on Solar Heat and its Absorption by the Earth's Atmosphere. A Report of the Mount Whitney Expedition. By S. P. Langley. Washington: Government Printing-Office. 1884. Pp. 242.

The Story-Hour. For Children and Youth. By Susan H. Wixon. New York: The Truth-Seeker Company. 1885. Pp. 222. Illustrated.

POPULAR MISCELLANY.

Electric Lighting in America.—At the meeting of the Society of Arts on December 3d, Mr. W. H. Preece read a paper in which he stated that electric lighting is flourishing in America much more than in England. There are probably ninety thousand arc-lamps alight every night in the United States. He had found it a dismal experience to be transferred from the brilliantly illuminated avenues of New York to the dark streets of London. On the evening of October 21st he drove from the Windsor Hotel, New York, to the Cunard wharf, a distance of about four miles, through streets entirely lighted by electricity. On arriving in London, he drove from Euston to Waterloo without seeing a single electric light. In Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, and Boston, he found the principal streets and warehouses, as well as stores and places of public resort, lighted by arc-lamps. Police supervision of the streets is rendered far simpler when they are brilliantly illuminated by the electric light. It is with arc-lighting that the greatest advances have been made in the States. In Chicago the number of arc-lamps installed has doubled during the past twelve months; it is now two thousand, and increases daily. More than one electric light company pays dividends to its shareholders, and all of the manufacturers of supplies are busy. The great ferry-boats of the Pennsylvania Railroad are lighted by electricity; those magnificent hotel-steamers that ply between New York and Fall River, those on Lake Superior, on the Mississippi and other large rivers, are either so lighted or are gradually being fitted for the lamps. Mr. Preece said that electric wires carried overhead, in the unsightly fashion which prevailed in the United States, were hideous in the extreme, and the only advantage he had found for them was that they afforded a welcome shade from the fierce glare of the sun. He had counted 144 wires on one post in New York, and six lines of posts might be found on Broadway, there being thirty-two companies in the city carrying wires on poles. There was no necessity for it at all, for it was found by the English Post-Office that, whenever the number of wires through a town exceeded fifteen, it was cheaper to put them underground than overhead.

The Oldest Land-Animal.—Mr. Lindstrom, of Stockholm, has described a fossil scorpion which has recently been found in the Upper Silurian strata of the Island of Gottland, Sweden. According to photographs forwarded to the French Academy of Sciences, the specimen is fairly well preserved, with the chitinous cuticle still visible. The cephalothorax can be distinguished, together with the abdomen with seven dorsal laminæ, and the tail of six segments, the last of which is contracted into a point and forms the poisonous sting. The superficial structure of the animal is quite similar, with its tubercles and longitudinal keels, to that of recent scorpions. One of the stigmata is visible on the right, to indicate that the animal was an air-breather, and the whole organization shows that it lived on the land. Mr. Lindstrom regards this as the oldest land-living animal yet discovered, the fossil dragon-flies of Canada having been found in the Devonian. It is remarked of this animal that the large and pointed character of the four thoracic paws is characteristic of the embryos of several other *Tracheata*, and had disappeared from fully-developed scorpions as early as the Carboniferous period. A similar fossil scorpion has just been found in the Upper Silurian of Scotland.

Parasites in Domestic Fowls.—On dissecting a fowl which had died from sickness, Thomas Taylor, M. D., of the Department of Agriculture, found reddish markings on the rib-muscles and the lungs, which under the microscope were seen to consist of numerous mites, closely resembling *Cytolcichus sarcoptoides* (Mégnin), a species not hitherto reported in America. When the skin was

removed from another fowl, great numbers of small, white, opaque specks were seen in the cellular tissue, and by means of the microscope mites were found, of the species *Laminosioptes gallinorum* (Mégnin). The opaque specks were of a calcareous substance, and many contained the remains of one or more of these mites. In the same fowl Dr. Taylor found thousands of encysted nematoids, resembling, under a microscope of low power, *Trichina spiralis*, but under a power of about 500 diameters they seemed to be of an undescribed species. A third fowl also contained mites of the species *gallinorum*. Dr. Taylor deems it probable that a considerable amount of disease prevailing among American domestic fowls, and not referable to any known type, may be due to such parasites. He suggests that carbolic acid, or other disinfectants, sprinkled about henneries, might prove useful as an antidote to these, and to external parasites.

The Ferment-Organism in Plant-Growth.—Professor Storer, of the Bussey Institution, in reporting upon his experiments with vegetable mold as a fertilizer, suggests that the activity of the development of the organism or ferment of nitrification is a very important factor in the action of manures, which deserves careful study. Indeed, he says, one of the first things now to be done in seeking to explain the agricultural value of the nitrogen in vegetable mold is to determine precisely what the ferment-organism is, and to study its habits and the history of its development. When this knowledge has been gained, "it will doubtless be practicable for the farmer to employ the soil-nitrogen in a much more intelligent way than has been customary hitherto. He will then be able to count definitely upon the soil-nitrogen as a resource in a sense that was hardly to be thought of by his predecessors. Many methods of tillage and of manuring, and some modes of mulching—the conduct of which is now purely empirical—and the whole subject of composts made with peat and loam, will undoubtedly then be brought into the domain of reasonable practice. For example, the question is now open whether the power of clover and root-crops to supply themselves with nitrogen may not depend upon the comfort and shelter these crops offer to the nitrifying ferment. It is not unlikely that the ferment-organism may prosper exceedingly beneath the dense shade of clover and other large-leaved plants, in the comparatively moist surface-soil which is peculiar to such fields. Perhaps even the manner in which the roots of those plants act upon the soil may have a favorable influence upon the life of the ferment. . . . So, too, in the case of Indian corn, a plant which grows vigorously in hot weather, it is probable that its observed power of utilizing the soil-nitrogen to better advantage than the small grains can will be found in some peculiarity of the crop which promotes the growth of the nitric ferment in the soil beneath it, and so makes the nitrogen of the vegetable mold available as plant-food." On this point, Jared Eliot, writing in 1747 on the importance of tilling Indian corn thoroughly, observed: "What is still more remarkable, if the Indian corn be well tilled, the next crop, whether it be oats or flax, so much the bigger and better will that succeeding crop be, so that the land must have gained strength and riches; if it were not so, why did not the Indian corn exhaust and spend the strength of the land, especially when we consider how large corn is made to grow by the good tillage?" Professor Storer predicts that the making of composts may, if his hypothesis is true, soon cease to be regarded as a subject of technical chemistry, and the consideration of the theory of composting may pass from the chemist's hands into those of the botanist or biologist.

Importance of cultivating the Eye-sight.—Dr. R. Brudenell Carter has published a paper urging that the culture and improvement of the eye-sight should receive a share of the attention that is given to physical development in other directions. He believes that it is not school-life alone, but the general conditions of civilization that have diminished our capacity of vision, and cites instances of sharp sight and long sight in savages, that were not regarded as at all unusual, where white men were exceedingly dull of vision. "Is there any reason," he asks, "why perfection of sight should not

be made a point of physical excellence in all athletic contests? The example might be fitly set by the volunteers, who might thereafter in time diminish the diameter of the bull's-eyes of their targets; and it would soon be followed by common schools and by athletic clubs. The tests would be easy of application, the value and uses of superiority would be unquestionable. A first effect would be to make people understand what they ought to be able to see, and a counteracting influence would be brought to bear against those conditions which at present render it difficult for the dwellers in large towns ever to look at a distant object. Important good results would not be immediate, nor could they be fully attained except in more than one generation; but I think it can not be doubted that they would ultimately follow. . . . The games which require close attention to a flying object, such as tennis, battledoor and shuttlecock, and in a less degree cricket, are among the most powerful agencies by which the muscles in question can be strengthened and improved."

Industrial Uses of Mica.—Mica has the invaluable properties of being proof against the attacks of every acid, totally incombustible, and impervious to the action of air and water, and of being indefinitely divisible into thinner and thinner plates. In consequence of these properties it is applicable to a great variety of purposes, and much attention has recently been given to its industrial use. Its manufacture into various articles has been carried on at Max Raphael's establishment in Breslau, Germany, for nineteen years, and has been constantly marked by improvements and new applications introduced from time to time. Its transparency makes it highly available for the glazing of microscopic preparations and the preservation of plant specimens. In England it is employed in the windows of machine-shops, where glass is liable to be broken by splinters of metal. More recently it has been employed in the membranes of phonographs and the diaphragms of telephones. Tablets of it are frequently inserted in the doors or walls of smelting-furnaces, to permit a view of what is going on inside without exposure of the eye. The dials of compasses and the window-lights of war-ships have been made of mica, to avoid the shattering of glass by the cannon-shots of hostile vessels. The mineral has been found extremely valuable for incombustible lamp-shades and screens. Being a poor conductor of heat, mica has been applied with great advantage to use in screens to be placed before open fires, by the aid of which the heat is more evenly distributed through the room without any part of it being subjected to an extreme exposure, while the cheerful light of the fire can be enjoyed at the same time without inconvenience. One of the most valuable applications of mica has been found in the making of spectacle-glasses from it, to be worn by workmen in foundries, machine-shops, and other places where hot metal has to be handled, or where the eyes are exposed to the intense glow of the furnaces. Mica in small scales or coarse powder is worked up into a mica brocade or pearl-glazing, for the decoration of articles of fancy. These goods are made in silver and other colors in considerable quantities, at shops in several German towns. The silver brocade is the natural white mica, pounded up, treated with hydrochloric acid, washed, dried, and assorted into grades of fineness by passing it through sieves. The colored varieties are dyed with aniline colors. The mica is applied to the articles it is intended to ornament by sprinkling it upon them, after they have been covered with gum, or a sticky earth, and then varnished, when very fine effects may be produced. The mica brocade is now preferred to the brocades formerly made with bronze, because it is not affected by the sulphureted hydrogen in the atmosphere, by which the latter always, sooner or later, becomes tarnished.

Forbidden Numbers.—Dr. Goldziher, an eminent student of Semitic lore, remarks upon the peculiar dread that some Mohammedan communities exhibit in respect to particular numbers. In Morocco, five is an object of terror, and it is not permissible, says Höft, to speak of five in the presence of the king; but we must always say four and one, fourteen and one, twenty-four and one, etc. The superstition may have originated in the fact that the hand, which may be

laid upon the king, or which is raised to forefend the evil-eye, and which is supposed in Northern Africa to have great magic power, has five fingers. According to the traveler, Ibn Batûta, the people at Sarmin, near Aleppo, will not speak of ten, but always of nine and one, and a mosque at that place has only nine cupolas. The Shiites in India take the greatest pains to avoid the number four, some of them going so far as to use six-legged instead of four-legged bedsteads; and if one of them inadvertently pronounces the number he will immediately clear his throat as if to spit it out.

The Oldest Geographical Society.—The Paris Geographical Society, the oldest existing society of that kind, was founded on the 15th of December, 1821, when 217 persons recorded themselves as members. Among these original members were men of great eminence in their respective fields of science. Of them, M. Vivien de St. Martin is the only survivor. The "Bulletin" of the society has been issued regularly since its institution, and the series now forms in itself a library of 120 volumes. It has published several volumes of accounts of travel, many of them of great value, and has awarded 150 prizes for geographical research. Its library includes more than 25,000 volumes and pamphlets, 3,000 maps, and 600 portraits of famous geographers and travelers. Most of the learned professions and departments of public service, and nearly all important nations, are represented in its list of members, in which also seven royal personages—among them King Norodom I, of Cambodia, and Sultan Syied Barghash, of Zanzibar—have had themselves enrolled. Since the Franco-German War, the society has paid particular attention to the study of geographical questions bearing on trade, to the exploration of newly-opened regions, and to the popularization of geographical knowledge.

Tastes for Strange Meats.—The fact, which is made evident by the condition of the remains, that the cave-men on occasion ate wolves, foxes, and similar animals, has been supposed to show that they were often reduced to great misery; but observations among living men prove that there are tastes in such matters that are often as potent as want. Some of the tribes of Alaska are capable of eating with relish things that it is disgusting even to mention in that connection. There are tribes in Kamchatka, Siberia, and Mongolia, according to travelers in those regions, that are fond of the flesh of wolves, foxes, and badgers, and some believe that it brings them luck in hunting. The Moquis Indians are said to esteem wolf's meat; and the Earl of Southesk, in the Saskatchewan, said that the flesh of the large wolf was "very good eating," that of the small one uneatable. Heusser tells of Indians in Brazil who find the meat of two species of this family much to their taste. Chapman says that jackal-meat is considered a great delicacy by the Balalas of South Africa, and that they were surprised to learn that the English did not like it. The striped hyena is believed to confer magic powers, and his flesh, hair, and teeth are objects of contention. According to Schweinfurth, the people of Charzeh, of Berber descent, eat all game, including hyenas. According to Livingstone, while the Maqua reject the flesh of hyenas and leopards, their neighbors, the Manganja, on Lake Nyassa, regard the flesh of the animals that "make discords in the chorus of the spheres" at night as delicious viands.

An Ascetic Indian Tribe.—Sir J. H. Lefroy speaks of the narrative reports of the officers of the Indian Survey as being full of ethnographic and other curious information. Take, for example, the account given by Mr. G. A. McGill, in 1882, of the Bishnoies of Rajpootana, a class of people who live by themselves, and are seldom to be found in the same village with the other castes: "These people hold sacred everything animate and inanimate, carrying this belief so far that they never even cut down a green tree; they also do all in their power to prevent others from doing the same, and this is why they live apart from other people, so as not to witness the taking of life. The Bishnoies, unlike the rest of the inhabitants, strictly avoid drink, smoking, and eating opium, this being prohibited to them by their religion. They are also strictly enjoined to monogamy and to the performance of regular ablutions daily. Under all these

circumstances, and as may be expected, the Bishnoies are a well-to-do community, but are abhorred by the other people, especially as by their domestic and frugal habits they soon get rich, and are the owners of the best lands in the country."

Wild Birds in Cities.—About fifty-five species of wild birds make themselves at home in the city of Paris and find their living there. All of the orders, except perhaps the climbers, are represented among them. One bird of prey, a pelerine falcon, established himself on the towers of Notre Dame a few years ago, whence he hunted the pigeons of the quarter, and a fisher-martin, leaving the marshes he was accustomed to frequent, when the water became too low for him, came to hunt insects and little fishes in the midst of the city, near the Pont des Arts. A number of woodcocks and rails, a season or two ago, haunted the ponds of la Glacière, and a few pairs of water-fowl made their nests in the same place. But these wading birds will probably soon have to seek another abode, for their domains are being reduced every day, and there will shortly be no trace left of the old marsh. A brace of quails are installed in the same region, whose presence is revealed every June by the well-known call of the male. The pigeons form, during the pleasant season, numerous colonies in the public gardens, where also establish themselves numbers of woodpeckers, linnets, red-tails, blackbirds, greenfinches, chaffinches, sparrows, and rooks; while swallows, martins, and jackdaws build their nests under the cornices of the houses or conceal them in chimneys, in the holes of old walls, and in church-towers. No species live on terms of closer intimacy with the human inhabitants than the sparrows, which everywhere seek the neighborhood of man. No bird has been more calumniated; but, admitting that they have mischievous traits, it is certain that they are most active and efficient destroyers of noxious insects. The English ornithologist Macgillivray asserts that without them the kitchen-gardens around London would not be able to furnish the market with cabbages; and M. Châtel, of Vire, regards them as the most useful of insectivorous birds. They are noisy and pugnacious, and seem better suited with city than with country life. They have multiplied wonderfully in all the European and in the American cities. M. Nérée Quépat, author of the "Ornithologie Parisienne," believes that there are three times as many sparrows in Paris as there are of human inhabitants, and, in view of the innumerable flocks of them to be seen in all parts of the city, it is easy to credit the assertion. The pigeons also are nearly as well domesticated as the sparrows, but are less constant in their attachment to their home, for they leave the city in the fall, to winter in a southern climate. They are exposed to capture and destruction during their journey by the people of Southern France, and their numbers are diminishing; so that, unless precautions are taken to save them from this persecution, Paris will in time know them no more.

Spider-Threads for Economical Uses.—We have already mentioned some of the efforts that have been made to spin threads and weave cloths of spiders' webs. They have so far fallen short of success, on account of the difficulty of getting enough of the fiber, and of the lack of strength of most spiders' threads. A few species of spiders encourage the hope that the manufacture of spider-cloth may yet become something more than a dream. Sir Samuel Baker describes a spider in Ceylon, two inches long, that spins a beautiful yellow web two feet and a half in diameter, so strong that a walking-stick when thrown into it is entangled and retained among the meshes. Mr. F. W. Burbridge, in "The Gardens of the Sun," describes a larger spider which spins a web strained on lines as stout as fine sewing-cotton. Dr. Walsh tells from personal observation of a still larger spider, the *Aranea maculata* of Brazil, whose web, ten or twelve feet in diameter, very sensibly entangled his head and forced him to leave his hat behind when he came out from it. Lieutenant Herndon, of the United States Navy, confirms this account, and estimates the diameter of a web he saw at ten yards. The furnishing of cross-lines for telescope-glasses can hardly be the only use to which these beautiful threads are adapted.

Testing Lighthouse-Lights.— Experiments have been begun by the corporation of Trinity House, at the South Foreland, England, to determine the relative value of the electric, gas, and oil lights as illuminants for lighthouses. The two lighthouses already established on the Foreland are illuminated by electricity, and are known as the high light and the low light. Near them have been erected three experimental lighthouses: one, provided with electrical lights that have a total power of 30,000 candles; a second, furnished with gas-burners, of Mr. Wigham's design, that may give a total of 12,000 candles; and the third, with the oil and gas burners invented by Sir James Douglass. Three stations have been fixed for testing the lights, at distances respectively of half a mile, a mile and a quarter, and two and a half miles, at which huts have been fitted up as photometric observatories. Measurements will be taken for determining the penetrative power of the several illuminants in different states of the weather, and for ascertaining to what extent the principle of superposition of lights may be applied. One of the questions to be determined is relative to the comparative value of a large area of low illumination and a small area of high illumination.

New Pests in exchange for Old.— The Australasian colonies have suffered greatly from the multiplication of rabbits, which were originally introduced there from England. Now, they are crying out against a plague of dogs, which, increasing rapidly, and semi-wild, have become very destructive to the sheep, and rewards are offered for their destruction. It is proposed to import stoats and weasels into New Zealand to put down the rabbits; but, if this is done, there is danger that the latter estate of the colony will be worse than the present one. The sugar-planters of Jamaica have suffered greatly from the depredations of rats among their canes, and mongooses have been imported to destroy them, with apparent general benefit so far. "But the new importation continues to multiply and spread, not only on sugar-estates, but on the highest mountains, as well as along shore, even amid swamps and lagoons; and, when the sugar-cane rat is wholly exterminated, the mongoose will still go on increasing, and what then? Must the colonists find something else to exterminate the mongoose, and save their poultry, and so on *ad infinitum?*" As it is, many of the harmless indigenous fauna of the island are already diminishing under its attacks.

NOTES.

Dr. B. A. Gould, of the observatory at Cordoba, Argentine Republic, writes to Professor J. D. Dana that, after fourteen years of absence from his country, he finds himself so near the end of the special work on which he has been engaged that he hopes to revisit New England in the spring. Four volumes of star positions have been published, and a meteorological volume is started on its way. He hopes to leave a mass of similar material for the occupation of his successors in the institutions; to leave the manuscript of seven astronomical quartos ready for the press; and to bring with him for publication in the northern hemisphere the "General Catalogue of Southern Stars," which will complete the astronomical work.

Mr. W. E. Garforth, of Normanton, England, has invented a simple apparatus for detecting fire-damp in collieries. It consists of a small India-rubber hand-ball fitted with a protected tube. By compressing the ball and then allowing it to expand in a suspected atmosphere, it becomes filled with the air. It can then be taken to a safe place, and the air can be tested in a lamp.

Success is claimed to have attended the operation of the system of jetties planted by Captain Eads for deepening the channel of the Mississippi River near its mouth. While there were formerly only from eight to thirteen feet of water over the bars at low water, the least depth through the jetties was, last May, thirty-three feet, and the channel is steadily wearing itself deeper.

At the recent meeting of the German naturalists and physicians at Magdeburg, Professor Landois, of Münster, spoke of the imperfections and comparative uselessness of most zoölogical gardens, and advised the institution of smaller gardens having well-defined fields of observation and investigation. He cited the successful example of the zoölogical section of Westphalia and Lippe, whose garden of native beasts yielded an annual surplus. In connection with this is established a zoölogical museum of the district, in which the biological side is kept prominent, and which is nearly complete in invertebrates. The section publishes scientific lists of the native fauna, and is preparing for a wider circulation a "Westphalian

Animal Life in Word and Picture," which is to be published in elegant style, and of which the first volume, the "Mammalia," is ready.

Dr. A. N. Randolph has made experiments on the behavior of the mixture of hydrocarbons called *petrolatum*, or, commonly, vaseline, in the digestive tract, by which he has learned that it passes from the system wholly unchanged. It is, therefore, valueless as a food-stuff, while it is at the same time entirely unirritating to the digestive tract.

Mr. A. V. Adrianof has contributed to the Russian Geographical Society an account of a people living in the basin of the river Kemtsik, called the Sayanians, or Sayantsi, who display a remarkable capacity for mixing with neighboring races without being merged. Many of their burying-places are of considerable antiquity, and are either marked by conical cairns or are flat areas surrounded by a circular row of stones. The stones are sometimes plain, but often covered with inscriptions, and bear in some instances rude representations of the human figure. In the immediate neighborhood of the tombs may be observed the remains of the sacrifice, the victim usually being a horse. Similar sacrifices are still offered, at which the flesh of the slaughtered horse is eaten, and the head and skin are raised on a pole.

A paper by Mr. F. Cope Whitehouse, stating his reasons for believing Fingal's Cave in the Island of Staffa to be of artificial construction, accompanied by photographs illustrating his views, was presented to the French Academy of Sciences at its meeting of December 1st, by M. Daubrey, the geologist.

M. Eugène Foucault, a French antiquary, has found in Brittany a bronze axe, with the handle attached—the first specimen of the kind known to have been found in France, and probably in the world. The tool is furnished with a cutting edge on one end, and a kind of hammer-cap on the other.

Professor Landois, of Münster, reported to the recent scientific assembly in Germany on his examinations of the viscera of Westphalian woodpeckers, for the estimation of the economical influence of the birds. They showed that those particular woodpeckers at least were decidedly useful and beneficial. Their food consists, summer and winter, of both animal and vegetable matter, but the latter is mostly the seeds of coniferous plants. The abundance of aphides and larvæ of diptera found in the entrails showed that the birds made a very extensive slaughter of minute insects. The simple percussion on the bark of the trees does no harm, and their nesting is rather beneficial than otherwise, for it anticipates the destructive life that would otherwise be hatched in the hollows.

OBITUARY NOTES.

Professor Benjamin Silliman, of Yale College, died in New Haven, January 14th, of dropsy induced by heart-disease, after having been ill since the 6th of October. He was in the sixty-ninth year of his age. He had been connected with Yale College as a teacher or professor since he graduated in 1837. He had been identified with the Yale (or Sheffield) Scientific School, which he organized, from its beginning. He was one of the Trustees of the Peabody Museum of Natural History, and was a member of numerous scientific societies on both sides of the Atlantic. A portrait and sketch of Professor Silliman were published in "The Popular Science Monthly" for February, 1880.

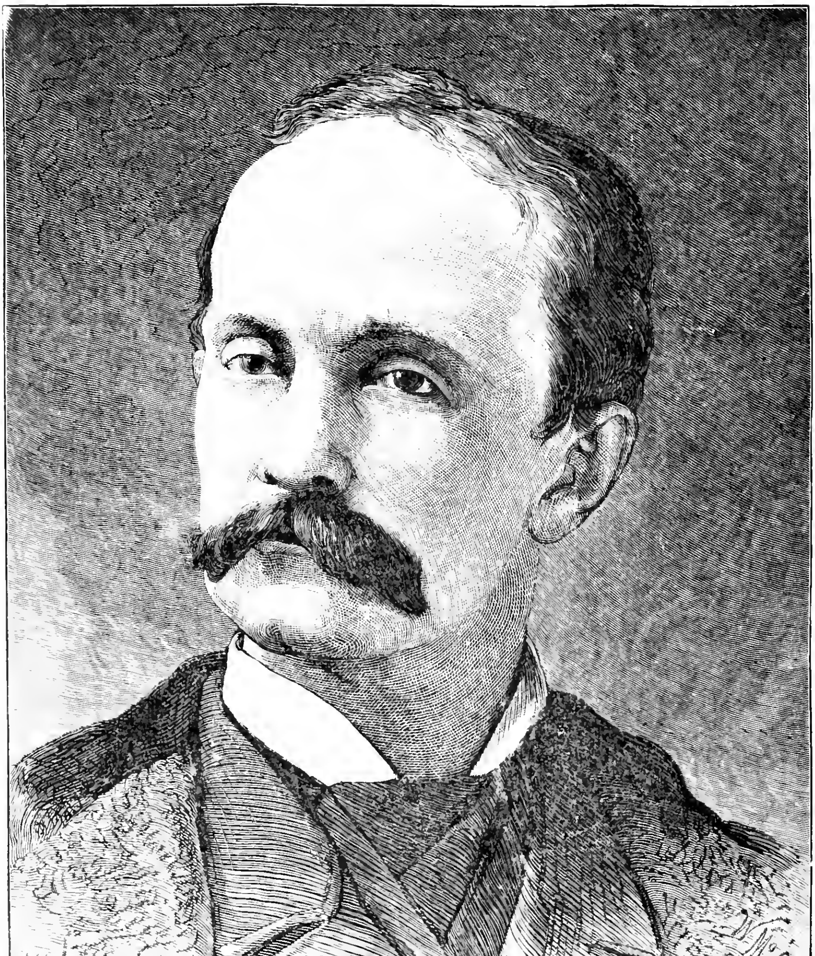
Mr. Alfred Tylor, F. G. S., of Carshalton, England, a business man, who also found time to contribute to the advancement of science, died December 31st, more than sixty years old. He was a brother of E. B. Tylor, the anthropologist, and had been the friend and the companion, in some of his earlier geological excursions, of the late Professor Edward Forbes. He was interested in questions of physical geology, including the formation of valleys, the erosive action of rivers, and the origin of gravels and other superficial deposits, on which subjects he was a frequent writer. He was also interested in questions of archæology and anthropology, and had enjoyed the pleasure of discovering some remarkable Roman remains on his own premises.

Mr. James Napier, of Glasgow, who has been long identified with chemistry and the manufacturing arts, especially with electrometallurgy, died, near the close of last year, at about seventy-four years of age. He was the author of "Ancient Workers in Metal," "The Manufacturing Arts in Ancient Times," "Old Ballad Folk-Lore," and of many memoirs in the "Proceedings" of the Philosophical Society of Glasgow.

M. Jules Bertin, a French forest-inspector, and author of several books on forestry, died in December last, at Boulogne.

Mr. Searles V. Wood, a British geologist, distinguished chiefly for his investigations of the newer Pliocene and glacial deposits of the eastern counties, died in December. He was author of several papers relating to his special subject in the Geological Society and the "Geological Magazine."

The death was announced, early in January, of M. Victor Dessaignes, a French chemist, who was distinguished for his delicate researches in organic chemistry. He was eighty-five years old.



JOHN TROWBRIDGE.

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THE CHARACTER AND DISCIPLINE OF POLITICAL ECONOMY.

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WALTER BAGEHOT once said of certain literary economists, who had no bent for practical affairs, that they were "like astronomers who had never seen the stars." In fact, no small number of people believe that this applies to all political economists; that they do very well as students of books, but are unable to keep their heads in the midst of facts and actual business; and that only the "hard-headed" merchant is competent to explain the causes of what he sees to the uninitiated. As in many general beliefs, there is something just and right in this; and yet there is something too which is not included in it, which leads the holder of the belief to narrow and illiberal conclusions in regard to a very important study. A fair and candid consideration should be given to the qualities of mind called into play by the study of political economy, and then we may more easily judge of the character of the work demanded of an economist, and of the way in which these demands have been met.

It is axiomatic that not every person can succeed in political economy any more than in art or music. Some people, although admirably equipped in other directions, have attacked political economy with great zeal, only to realize finally that anything beyond a certain general knowledge and use of its principles is denied to them. Any hint, therefore, although imperfect as mine may be, of a knowledge of the mental qualities requisite for success in such a study, will at least set to thinking those who propose to begin it, and possibly lead those

who do not intend to study it to consider whether they have formed a right judgment upon the work already accomplished by economists.

The mental qualities brought into use by political economy are of two seemingly opposite kinds; and, simply because of this distinct opposition between them, few persons combine them both, and consequently few persons have achieved great success in the study. To illustrate best the mental operations required, let me first recount briefly the process followed in an economic investigation. Certain phenomena are observed, and their accuracy ascertained; an hypothetical explanation, or a statement of the cause operating to produce the observed phenomena, is made on the best possible ground known to the investigator; a process of verification then follows, wherein the hypothetical principle is applied to other observed economic facts; and, if it explains the given conditions in all known cases, the law is considered established—just as we proceed to discover a law in physics (although the economic law is not capable of quantitative accuracy in statement like the physical law). First, there is observation, then deduction, and lastly inductive verification, with a severe and exacting standard. Or, to again use the words of Bagehot, we act as if a man were arrested under suspicion of murder: a murder was known to have been committed, and the doer of the crime has been suspected; and then, if, on resort to legal and just proof, the suspicion is found correct, he is declared guilty. Likewise, when economic phenomena are observed, the law expressing the relation between cause and effect is suspected; and if, on comparison with the facts, this law is wholly substantiated—as it were, "found guilty"—it is considered established.

By the deductive part of the process, the *logical* and reasoning powers are called forth in a marked degree. Hence economic study needs, and in its processes gives, the discipline of the severer logical and mathematical subjects. And many years of observation in the classroom warrants the statement that, as a rule, he who enjoys and masters mathematical and logical work will succeed with political economy, provided he has to some extent also the other necessary mental qualities. What these other qualities are may be seen by considering that, in the inductive part of the process above described, an imperative need exists for an honest, practical *appreciation of facts*, such as is possessed by merchants and men of affairs, coupled with an *economic intuition*, a faculty which is more or less innate, and not very much, in my opinion, a matter of cultivation. The capacity to collect and arrange facts is a book-keeper's function; but the ability to see through the confusing mass of details and trace the operation of a governing principle, requires an intuitive regard for facts and their causes possessed in a large measure hitherto by only a few men. If this analysis be a true one, it will appear distinctly how it is that qualities almost diametrically opposed to each other are necessary for

the equipment of an economist of the first rank. On the one hand, he must have the power of close, sustained, and logical reasoning; on the other, he must have a most thoroughly practical spirit, without vagaries and nonsense. The former he gains chiefly by his academic training; the latter, by general maturity and an intuitive or practical knowledge of the world of business. In short, he must be at once a (so-called) "doctrinaire" and a "practical man." To be without one set of these faculties is to seriously and fatally prevent any great usefulness. A purely "practical man," without the logical training, can no more achieve economic success than a railway-locomotive, no matter how great its steam-power, can continue to run and reach its destination without rails. And yet, a bookish and literary economist, without the practical intuitions, can accomplish nothing more than a finely finished and most perfect engine in the hands of an ignoramus who does not know how to get up steam. We here find the explanation of a very common belief among the wide ranks of the busy and successful men of affairs in the United States—a class who have generally had little academic training—that economists are mere "doctrinaires," whose assumptions are all *a priori*, all in the air, and above the level of every-day work; who had better make a fortune in pig-iron, or fancy dress-goods, before they set up to instruct the community. Merely making money, however, does not at the same time make one logical. It is as if we should demand that every scientific physicist or chemist should have first put his knowledge into practice by inventing some application of electricity, or a patent-medicine, before he is competent to impart the principles of his science to others. The contempt of the practical world for (so-called) "doctrinaires" is as great a mistake as for the speculative writers to set themselves above the men of affairs. As in most things, the correct position lies somewhere between. If an economist is an abstract thinker, and nothing else—unable to verify his deductions—then he justly merits contempt; but in that case he is not a properly equipped man, as we have described him above. On the other hand, it is common to see merchants or manufacturers showing great energy in studying and writing upon economic subjects, who, so long as they confine themselves to the range of facts within the limits of their own horizon, make most valuable and effective contributions to the verification of principles; but, when, without accuracy, logical power, or a grasp upon governing principles, they begin to generalize upon their limited data, they are very apt to be less effective and useful than they are dogmatic. He only is truly an economist who, eagerly studious of facts, not in one occupation or place only, but in as many as possible, applies scientific processes to his investigation, and produces that which becomes the world's truth, the property of men of all times—not the petty sum of thought which has grasped only a small fraction of the facts. In other words, when a wide-awake man goes to books, he

really goes to get the experience of the best observers of all countries with which to correct himself against false and narrow inferences drawn from his own limited experience.

In order to show how far this analysis is based on experience, some appeal to the history of the work of the most successful economists will give results of an interesting and instructive kind. Adam Smith, Ricardo, Mill, and Cairnes combined in a high degree the two almost opposite kinds of powers needed for their success; and these men have contributed the most to the progress of our knowledge of economic principles. It would be hard to name an author who has wielded a greater influence by his writings than Adam Smith by his "Wealth of Nations" (1776). His work was a great and admitted success, as tried by any tests, whether of popularity or permanent influence on men's minds. But on his tombstone will be found inscribed the name of an extensive ethical work ("The Theory of Moral Sentiments") as an equal claim to distinction with the "Wealth of Nations." What is worth noting is that the great writer was a Professor of Moral Philosophy in Glasgow, and had planned an extensive course of lectures in which political economy formed but one part; and we find that by training, by aptitude, by study, he was a skillful master of logic; he had the power to separate the temporary and unimportant from facts, and educe an abstraction of the truth unweighted by the accidents of the form in which he found it; and knew how to secure a firm grasp upon principles apart from their illustrations, which gave him later a scientific and systematic control over his subject, and enabled him to weld it into a compact and cohering whole. It was this power which made it possible for him to lay the foundations of a science of political economy. It widened his views, and made it easy for him to see the essentials of any concrete phenomena. In short, he possessed in a remarkable degree the first of the two requisites for successful economic work. But, then, to an almost equal extent, he honestly reverenced industrial and commercial facts; he studied them eagerly, and made his book an extensive collection of data on many special subjects. Everywhere one meets with the analysis and study of particular industrial phenomena; and in them the keen, observing Scotchman, with a subtile, economic instinct, saw the operation of laws where the ordinary man of affairs saw only a crowd of familiar and monotonous details of business. The practical nature of his work is so well known that it seems unnecessary to call further attention to this side of his make-up. So well is this understood, that the late Cliffe-Leslie claimed for Adam Smith that his method of working was solely inductive, that is, starting from facts alone. It was, therefore, without question, his philosophic and logical faculty, united with a true and correct instinct for facts and the laws working in them, which lay at the bottom of Adam Smith's world-wide success in his "Wealth of Nations." He had the power to see the universal in the concrete; to

disclose the operating force; to shake off the incidental circumstances of its concrete envelope, take out the principle, and formulate it for use by others in subsequent explanations. The great Scotch "doctrinaire" was at once the most practical man of his time.

Curiously enough, while Adam Smith approached political economy from the side of abstract and metaphysical studies, his "homely sagacity" led him constantly to practical results; but, although Ricardo was a rich banker and a successful man of business, who had early retired with a competence, he it was who, above all others, went farthest in attempting to formulate the principles he had arrived at from facts in a form which should state abstractly the general truths independent of the changing conditions in which these principles worked. So that in Ricardo we have a man of business intuitions of the most practical kind, but one who early showed a fondness for mathematics and logical studies. Knowing only too well the myriad shapes in which facts arise before us, he was urged forward by a desire to express truth in a form as succinct and universal as possible. This tendency, taken in connection with unusual terseness and no great literary skill in exposition, has deceived people into thinking that his conclusions were all deduced by an *a priori* process (because of his dry and peculiar method of stating them); while, as a matter of fact, he was a hard-headed man of affairs, living at a time when the Bank of England restriction act and the duties on corn led him to try to find out the fundamental principles which were governing the value of money and the price of corn. The results of these practical investigations were seen in the doctrines of the "Bullion Report," and the economic doctrines of "Rent" and "International Trade." In this way, the work of the Scotch Professor of Logic, who had a great deal of practical insight, was supplemented by the study of a successful man of affairs who had a strong passion for concise and abstract statement of economic principles. We can not properly say of the man who was introduced to the details of the money market at fourteen, was in business on his own account at twenty-one, and was a wealthy man at twenty-five, that he was a doctrinaire wholly given over to abstract speculations.

John Stuart Mill illustrates what we have said in a different way. To him the fascination of abstract reasoning was so great, and the bent of his mind so strongly metaphysical, that this part of the economist's equipment preponderated in his make-up; his attention to the facts of practical life was not excessive. And this exposes the real weakness of his book. Perhaps no other systematic writer ever gained such a success by perspicuous treatment, and a certain geometrical symmetry in the connection of parts with a whole, as did Mr. Mill in his "Principles of Political Economy," and this quality has greatly added to the value of his work. But, while the abstract character of many of his chapters excites admiration for a power of sustained

reasoning which they showed, yet it must be confessed that they are too often ill-adapted to the common apprehension. Had he possessed more knowledge and acquaintance with practical business life, been nearer to the monotony of details, his work would have been imbued with a smack of practicality which would have redeemed its abstractness, and made it vastly more useful. Moreover, he would, as in the discussion of the wages question, have adapted his principles more correctly to the truth, and gained positions less likely to be assailed after others had noted their too great symmetry and too few limitations. His early training accounts for his book as it stands, and explains his faults. Account must, however, be taken of the life Mill led as a servant in the East India Company's office, which widened his horizon, gave his mind practical employment, and furnished him with a great field of experience in men and things. This, without doubt, exercised a strong and steadying influence on his thinking, which had some of the faults of English insularity, and, taken together with his robust philanthropy, gave that practical direction to his work which, while it was inadequate, yet redeemed him from the charge of being too entirely given to abstractions. Had he had an interest in work-a-day things which equaled his fondness for metaphysics and abstract thinking, he would have succeeded even more than he did, and he made a great success. His treatment of international values is a conspicuous example of his faculty for extended reasoning, but, had he put it more as a practical man of affairs, he could have made an exposition of the principles quite as well as he did, and gained vastly in his hold upon the reader. Does it not become evident, then, that mere philosophic acumen is not sufficient in the model economist? Nor, on the other hand, is the mere man of affairs able to grasp the workings of principles in the confusion of details. These two powers must be, and always are, combined in him who accomplishes the best economic work.

The personality of Mill's great successor, Mr. Cairnes, is a very interesting one. He both knew and thought much. Members of Parliament would come to sit by his invalid's chair, in which he was confined by a painful disorder, finally ending in an untimely death, and find him more learned than they in the details and facts of certain legislation; and yet with this accumulation of practical knowledge, for which he had a peculiar aptitude, no one since Ricardo has shown so vigorous a faculty for investigation, and the power of keeping his head while in the pursuit of principles. He was not befogged by metaphysical niceties, but followed his way through the multiplicity of actual business life with as sure and certain a grasp upon the actuating causes, and with as clear and definite a view of the principles in operation, as an expert accountant when adding a column of figures. His logical and philosophic side is most admirably seen in his little volume, "The Logical Method," in which he lays down his

ideas as to the processes to be followed in an economic investigation. Nowhere else does he seem more clearly to show how essentially he had the power to handle a purely abstract question, such as that of method. And yet, on the other hand, it is to be noticed in his "Leading Principles," that the whole criticism, by which he amends Mr. Mill's positions—his study of value, the wages question, and international trade—shows how much more appreciation he had of the real facts of trade than Mr. Mill. Under his economic penetration the cold columns of Australian statistics, and American exports and imports, glow with brilliant illustrations of general economic laws. Armed with this firm grasp upon principles, and the ability to see their operation in practical affairs, he examined the facts of our foreign trade before 1873, and came to the conclusion that we were rapidly accumulating the material for a great financial explosion, and actually prophesied the panic which came in that year. Scarcely anywhere is there a better illustration of the success arising from the possession of these two almost wholly unlike powers of mind which I have been trying to show are essential for the highest achievement in political economy. Mr. Cairnes was an economic tight-rope walker ; he could go with a cool head through airy spaces where other men became dizzy or fell to the ground. And, at the same time, he had the Englishman's sturdy respect for facts, with more than the ordinary Englishman's willingness to acquaint himself with social systems different from his own.

These economists, whose powers I have attempted to analyze, have been the ones who have contributed most to our knowledge of the principles of political economy, as they are understood to-day. Above all other writers, these men have possessed a useful economic intuition, and a respect for facts, which have given peculiar strength to their clear, abstract generalization of results in the form of universal principles. Wherever other students and writers have accomplished less, it will appear that weakness arose from their entire or partial lack of one or both of these two sets of faculties. It explains some other things also. French writers are unexcelled in the power of lucid statement ; but the generalizing and less practical French are not so likely to be good economists as the more common-sense English. Therefore, while the French have never much assisted the progress of political economy, they have stated results in the most admirable way. It is, then, reasonable also to expect that the practical Americans, with their keen insight and thoughtful disposition, may also furnish the material for excellent economists, whenever they set themselves seriously to get the proper training.

It may now be worth while to explain briefly some of the evident ways by which the study of political economy disciplines the mind. It may seem somewhat startling to say of so practical a sub-

ject that, in a pre-eminent degree, it calls for the exercise of imagination. "That is just what we have always said," the scoffers at political economy say at once; "so does novel-writing call for imagination, and a novelist is about as well fitted for the economist's position as the usual abstract thinker who masquerades as a teacher of political economy." To this it is to be replied that imagination is one of the chief requisites for mathematical study also; that a novelist is not necessarily a good mathematician, goes without saying. The simplest propositions of solid geometry require the exercise of imagination, as, for example, in the picturing of forms and solids with intersecting planes. The most logical student of the severest mathematical processes is called on for the exercise of this species of imagination. And so it is in political economy. In learning the subject, the perception of a simple general principle is often absurdly easy, but, for its assimilation into our own thinking, it is necessary that it should have become an interpreter of facts everywhere about us. To this end, it is essential for us to apply the abstraction, or general principle, in every possible case, to some concrete phenomenon. Very often, in order to show the action of this single principle operating by itself, we must separate all conflicting agencies from the situation—just as the physicist experiments in a vacuum exhausted of air, for the purpose of learning the full effect of a force, like gravity, when acting by itself. The economist, however, is not able to reproduce a given situation to the eye or ear, as is the physicist. He can not pile before him the exports of the United States or England, or summon before him the laboring-class or the capitalists of a country; he must, therefore, picture to himself the actual facts, just as the geometrician does the solid, and see how the operating principle works. This is very far from "theoretical dreaming." It is at once a most difficult process, and a most excellent discipline in learning how to think on such subjects. To illustrate my meaning in a simple way, it is one thing to say that in order to have value a commodity must satisfy some desire, and be hard to get; and quite another thing to be able to call up in the mind an image which will show the application of the principle. For example, to a shipwrecked sailor on a rocky island a bag of gold has no value, for it can not keep him alive. It is largely by such mental exercise as this that a student best succeeds in assimilating the body of principles which make up the science of political economy. It has been frequently said to me, "I can understand the statements of the writer easily, but I do not seem to be able to use the idea when called upon to explain things in a different connection." This is exactly the difficulty, as it is also, by struggling with the difficulty, the disciplinary gain of our study. To understand an abstract principle, without the ability to see it in the concrete form, and test its truth, is of little gain to any one. This would in truth make a "doctrinaire." The only "practical man," in any conceivable sense, is he who, while seeing

general principles, can best interpret the facts around him. To follow through a course of political economy without this attempt to think out the principles by use of the imagination, and by constant application to familiar facts, is like trying to climb a perpendicular slope of ice—the student will not catch hold.

In the next place, the disciplinary power of the study is very much that which is gained in the study and pursuit of the law. The beginner first gets an understanding of the principles, and he is then constantly engaged in turning with them to the economic phenomena around him as an exercise in their application. Or, struck by some new or interesting fact, he studies to find the law which explains the observed effects. In thus applying general principles to explain special facts, the economic student is doing almost exactly that which he does when, in the profession of the law, he applies legal principles to particular cases, or considers whether the interpretation of the law in one decision applies also to the special case he has in hand. The modern theory of legal teaching no longer recognizes the plan of simply filling the mind with statements of what the law now is, but aims to force the student, under oversight, constantly to apply principles to multitudes of cases, or to discover the principle running through the studied cases. It will, then, be seen that this process is much the same as in political economy. Consequently, quite apart from the "usefulness" of our study, its training is an excellent preparation for legal work, and strengthens the powers which are most called into play in that profession.

Moreover, this kind of mental exercise is continually calling upon one for the ability to see the pivotal part in any statement, whether of fact or principle. Not to see the essential bearing of an exposition is a species of mental blindness; but exercise will gradually give clearer vision. Nothing is more common in the replies of untrained students to questions than the happy-go-lucky kind of answers which bear upon the general subject, but are aside from the point. Persons may write or speak *about* the question, but do not answer it; what they may say may be quite true in itself, but it is irrelevant. The faculty of hitting a point is one, in my opinion, like concentration of mind (to which it is nearly allied), which is largely capable of cultivation and growth. And the discipline of rigorous study in political economy is one of the best means of acquiring it. In my experience, there have been some interesting illustrations of this analysis. Trained lawyers have, by heredity, transferred this faculty of directness of thought to their sons; and it has been possible, sometimes, without further data, to pick out the sons of lawyers from reading their examination-books in political economy. These sons "hit the nail on the head," and made clean work of their answers, without any mental shuffling, or avoidance of the essential point.

To make progress in such a study, the student must necessarily

gain exactitude and clearness, both in writing and speaking. Nothing is more striking to the instructor, as he faces a new class, than the limited powers of expression possessed by young men who have, in most cases, had a very extended course of classical training. It is largely due, of course, to vague and loose thinking. He who has clear ideas can generally manage to convey his meaning, in varying degrees of force, correctness, and elegance. The necessity, however, of making clear distinctions between things, which at first seem all alike, to see forces operating where none were seen before, stimulates unused faculties, and then progress becomes distinctly visible. Men who at the beginning expressed themselves in halting, inexact, and timid words, with a seeming passion for brevity, will, at the end of the course in which they have been constantly pushed to express themselves, talk easily and freely on subjects which would at first have frightened them by an appearance of abstractness. In this respect, the training must be much like that in the study of metaphysics. Under constant criticism looseness of words and definitions will disappear—as clearness of ideas comes in. In no other study is inexactitude and lack of precision in words or facts more likely to stir up criticism and ridicule than in political economy, because in no other study are persons more concerned with things which affect all the world in every day of its existence, and in which absurd results and stupid mistakes are more easily seen by everybody. The economist must be vigilant and correct; and the results of this requirement are such as tend to keep him as careful and exact as is possible. The effect of training under such conditions is admirable.

One other marked result of the study of political economy deserves at least passing mention. Persons who by nature are unfitted for other kinds of academic work, and yet by custom or authority have trodden the beaten educational paths with a dull sense of discouragement and incapacity, have, in many cases, been awakened to a hitherto unknown interest in study by the practical and interesting nature of the subject. Economic questions confront them everywhere, and they meet with the discussion of them over the table, on the walk, and in the newspapers. It, consequently, stimulates even a sluggish disposition to find that he can know something valuable about such practical matters of every-day importance. Livy or Thucydides may pall on his incapacity, but his curiosity may be piqued by having the functions of money explained to him. The purchasing power of his yearly allowance is something which comes home even to him. As enlarging the field for willing mental activity, and giving new and interesting objects for intellectual effort, political economy forms one of the most effective factors in the movement which in these latter days is liberalizing our courses of study, and is freeing us slowly from the cramped tyranny of a traditional training, still demanded, because, forsooth, it once seemed good to the school-men. Willing, enthusiastic study, because

it interests and fits the faculties, is a better thing for discipline than the serfdom of drudgery in a subject which excites no spontaneous response, and stirs an unwilling effort. And this is true, also, without any thought of undervaluing other branches of study. We must all admit that some minds are better fitted for one thing than for another, and that we can not do all things equally well. There is, therefore, a place for different studies so long as human abilities remain of a varied kind, and room should not be denied to any branch of learning which, apart from its "usefulness," is effective for mental discipline.

A warning, however, should be given at the outset which may save later disappointment in some cases. No one would think of becoming an accomplished chemist or geologist in one course pursued for one year; but many persons conceive that they can easily know all of political economy that is necessary for a sound judgment on passing questions in a less time than that. It is true that they can read over the statement of principles in a less time, but they can not become economists so easily. To have been trained until these principles become familiar as the alphabet requires time—time not merely for the intellectual efforts of applying the principles, but time for the mind to mature under the exertion and to digest its food slowly; since only by growth and experience does there come any development of the economic intuition, and a power to call readily upon any part of one's acquisitions for instant use at any moment. An elementary course will serve a distinct purpose as part of a liberal education for every citizen, but it will not make an economist "*teres atque rotundus*" at once; although honest work in a course for a year will give students no small advantage over those who have not had it. A brief course in chemistry may not enable the student to contribute at once to a new theory of heat, but it may give him a highly useful knowledge of the chemistry of every-day things. We must not, therefore, expect more from political economy than we do from other serious studies.

THE NERVOUS SYSTEM AND CONSCIOUSNESS.

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I.

IT is the design of these papers to consider some of the more recent experiments and opinions as to the relations between nerve-matter and consciousness. The subject has been much be-written; the final word, however, is not in print, or likely to make its appearance there for some time to come. This is plain enough to anatomist and physiologist, and the general reader may assure himself to the same effect by reference to the proceedings of the Society for Psychical Research.

These proceedings offer a considerable number of facts not readily classifiable under any theory now at hand.

There is present and urgent need for a clear statement of the case respecting nerve-matter and consciousness. There is equally urgent need that this statement should be reasoned upon according to the fundamental working of reason—viz., the detection of difference and similarity. It is the proper reward of modern science to have taught that reasoning is the procedure from the known to the unknown by the pathway of resemblance. This resemblance must be experimentally determined and experimentally verified. Dr. Maudsley says, most truly, in his last edition of the "Physiology and Pathology of the Mind": "It will not advance knowledge to identify phenomena of a different kind by giving them the same name; on the contrary, the progress of knowledge lies in following the specializations of development, and in defining differences by a precise use of terms." The characteristic phenomena of nerve-matter and the characteristic phenomena of consciousness should be stated and compared: if these phenomena prove different, they should be described in the light of that difference, and all conclusion as to their origin should be drawn according to that difference. Our first inquiry, then, is concerning the nervous system, as to its parts and functions.

The histological elements of the nervous system are two, the fiber and the cell. The fiber appears under two forms, the medullated and non-medullated. The medullated fiber consists of a central thread or axial band, then a soft substance called the medulla, and, inclosing these, a tubular sheath. The axial band is the essential anatomical element of the fiber. It is an albuminoid substance—that is to say, it is highly unstable in character and complex in structure. The medullary substance is transparent, homogeneous, and strongly refracting, like oil; it consists chiefly of lecithin and cerebrin. The sheath is a lime-substance. The differences in chemical composition between this axial band and its marrow-like inclosure were shown by Lister and Turner in 1859. The band becomes red by a solution of carmine, while the marrow substance is unchanged, and in turn this substance becomes opaque and brown under chromic acid, while the band remains unaltered.

The second element of nerve-matter is the cell. This, in its fully developed condition, is of irregular shape, with strongly refracting granular contents and a distinct nucleus and nucleolus. Many of the cells have one or more prolongations, and are accordingly classed as unipolar, bipolar, or multipolar. One at least of the processes of a multipolar cell is continuous with a fiber and is called the axial-cylinder process. In the cells and in the intercellular substance of central nerve-organs, albuminoid stuff is closely mingled with the other component parts of nerve-matter.

The proportion of solids to water is but twelve per cent in the

cells, while it is twenty-five per cent in the fibers. This fact, taken in connection with the much greater provision for distribution of blood to the cell-mass, is strongly confirmatory of Mr. Spencer's opinion that the cells liberate motion by destruction of their substance, and the fibers by isomeric transformation.

The nerve-matter thus described is distributed over the body by two divisions—the great sympathetic and the cerebro-spinal systems. The latter alone concerns us in this paper. The nerve-matter of the cerebro-spinal system is found in the spinal cord and the encephalon. The spinal cord is a nearly cylindrical mass, from fifteen to eighteen inches long, and connected at its anterior extremity with the brain.

The cell-matter lies at the center and forms a continuous ganglionic band. The fibers are on the outside, and are divested of their tubular sheath. The central cell-matter of the cord is curiously shaped into two partial crescents, which are connected with one another by cell-substance called the gray commissure. Thirty-one pairs of nerves arise from the sides of the spinal cord and supply the entire body, except the head and other parts receiving branches from the cranial nerves. Each nerve leaving the cord contains, at its origin, all the filaments into which it may afterward be divided. Each filament or fiber remains anatomically distinct throughout its course. The fibers in the cord are connected by a commissure called the white commissure, and those on different sides of the cord extend longitudinally and are parallel to each other. Some of these longitudinal fibers, passing from below upward, convey impulses to the cord or brain; others, descending from the brain and higher parts of the cord, transfer motor impulses to muscles. Without presenting more anatomical detail, it is sufficient to say that the halves of the cord are unified by the fibers of the commissures, and that it works as one organ.

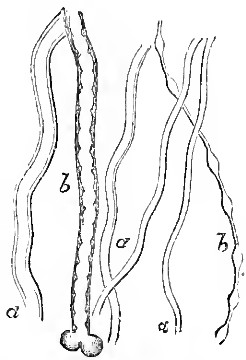

Fig. 1.—Human Nerve-Fibers of different sizes (Kölliker). *a, a, a*, healthy fibers, the largest of which is "dark-bordered"; *b, b*, fibers altered by exposure. Magnified 350 diameters.

The nerve-matter of the encephalon is divided into three principal parts, viz., the medulla oblongata, the cerebellum, and the cerebrum. The medulla is a continuation and enlargement of the spinal cord at its entrance into the cranial cavity. Here the anterior fibers of the cord become the anterior pyramids of the medulla, while the posterior fibers of the cord are called the restiform bodies. Immediately to the side of the pyramids are projections called the olivary bodies. The medulla is about one and one quarter of an inch long, and one inch broad at the widest part. There is cell-matter in the restiform and olivary bodies, a part of this matter being continuous with the cell-matter of the cord, and a part consisting of independent masses. Di-

rectly above the medulla is what is known as the pons Varolii. There are masses of cell-matter scattered at irregular intervals through the pons, but it is made up principally of longitudinal and transverse fibers.

The longitudinal fibers connect the medulla with the cerebrum, while the transverse fibers unite the halves of the cerebellum. This organ, the cerebellum, is made up of two hemispheres or lateral lobes and a median or central lobe. The cell-matter lies on the outside, the fibers are within. The external surface of the organ has a foliated appearance, caused by its subdivisions into multitudes of thin plates by numerous fissures. This subdivision allows great increase of cell-matter by numerous fine convolutions, and the matter is further augmented through penetration within of arborescent processes of cell-substance.

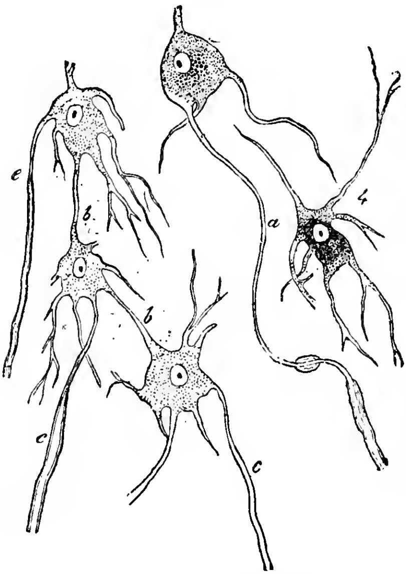

Fig. 2.—Motor Nerve-Cells connected by intercellular processes (*b*, *b*), and giving origin to outgoing fibers (*c*, *c*, *c*. and *a*). 4. Multipolar cell containing much pigment around nucleus. Diagrammatic. (Vogt.)

The next portion of nerve-matter to be noticed is the cerebrum. This makes up more than four fifths of the contents of the encephalon. The cerebrum is egg-shaped, but flattened on its under side, and lies in the cranium with its small end forward. It is divided into halves or hemispheres by a great longitudinal fissure. These halves, however, are connected by a middle portion of nerve-substance called the corpus callosum. The surface of the cerebrum is molded into numerous convolutions marked off from one another by furrows. The cell-matter of the cerebrum is external, it follows the convolutions, and is from one twelfth to one eighth of an inch in thickness.

The hemispheres of the cerebrum have been divided into lobes called the frontal, parietal, occipital, and temporo-sphenoidal lobes. These divisions are in part arbitrary, while in part they rest upon certain primary fissures, such as the fissure of Sylvius and the fissure of Rolando. It should be borne in mind that these different regions of the cerebrum are not distinct departments physiologically independent. The convolutions are exteriorly connected among themselves and also with convolutions of neighboring lobes. They have, besides, interior connections through bundles of fibers which pass from one convolution to the base of an adjacent convolution. If we remove the encephalic mass and look at it from beneath, we see the medulla as a continua-

tion and enlargement of the spinal-cord ; above this we see the pons Varolii, and to right and left the lobes of the cerebellum which lie under the posterior portions of the cerebrum. At the upper part of the pons we see two stems or crura passing to the cerebrum, and serving to join that larger organ with the nerve-matter below.

A little above the crura, and near the center of the mass, we see what is called the optic commissure. This is simply the crossing of the optic nerves on their way to the eyes. Directly below this commissure are two small rounded eminences called the corpora albicantia, while above, on a stem, is the pituitary body. Beyond the optic commissure lie the olfactory bulbs, one on each hemisphere, placed in a slight depression of the surface. If we turn the brain over, its numerous convolutions are seen extending from end to end, from side to side, and also following the lateral surfaces right and left of the great longitudinal fissure.

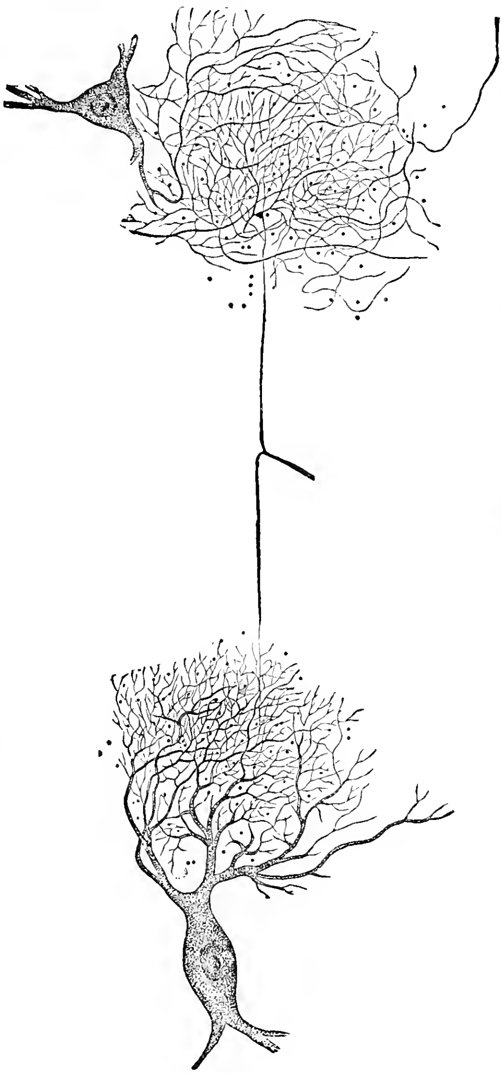

Fig. 3.—Division of a very slender Nerve-Fiber, and communication of its branches with a plexus of fibrils in connection with the much-branched processes of two nerve-cells. From spinal cord of ox. Magnified 150 diameters. (Gerlach.)

On removing a horizontal piece from the upper portion of each hemisphere, the cell-matter of the surface will be found to follow the different windings, while the center of each convolution will be seen to be made up of fibers continuous with fiber-matter in the interior of the hemisphere. Should we cut deeper, we would come upon the corpus callosum, the band of connection between the hemispheres ; this body is

composed almost wholly of fibers passing transversely between the two sides ; it makes the hemispheres anatomically and physiologically one. Were we to continue our section straight through the middle line of the callosum, we should reach a lateral chamber in each hemisphere. This chamber contains two rather large bodies called the corpus striatum and the optic thalamus. The stems or crura cerebri previously mentioned pass into these bodies before spreading out through the hemispheres. The striatum is shaped somewhat like a pear ; it lies in the chamber with its small end forward, and is composed of alternate layers of cell and fiber matter. The thalamus is ovoid, and presents an almost continuous mass of cell-matter traversed by fibers. The researches of J. Luys, of which a condensed account may be found in Vol. XXXIX of the "International Scientific Series," are most interesting as respects both anatomy and functions of the thalamus. Luys has discovered four isolated ganglia of cell-matter in the thalamus, situated one behind the other. He has also traced connections between these ganglia and certain organs of special sense. Behind and between the thalami are two smaller bodies called the optic lobes. They consist of two rounded eminences, the anterior ones being called the nates, the posterior the testes. The optic tracts, forming the optic commissure previously mentioned, proceed from the nates, the testes being connected by a band of fiber-matter with the cerebellum ; commissural fibers join these optic lobes with the thalami.

I have now named the leading portions of the cerebro-spinal system, and have indicated their general connections with one another. They are nothing more nor less than a series of nerve-ganglia connected among themselves by transverse and longitudinal commissures. This system shows us matter in its most highly organized condition ; further, this system shows us matter in some positive and necessary relation to consciousness.

The conclusions which we draw respecting the nature of this relation must, as has been said, be determined by a comparison of the

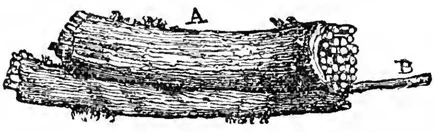

Fig. 4.—Portion of the Trunk of a Nerve, consisting of many smaller cords wrapped up in a common sheath. (Quain, after Sir C. Bell.) A, the nerve ; B, a single cord drawn out from the rest. Magnified several diameters.

known functions of the system with the distinctive characteristics of consciousness. I come, therefore, now to consider the functions of the cerebro-spinal system in so far as these are known, and in so far as they may be inferred from recent experiments and pathology.

Functions of the Cerebro-spinal System.—Nerve-matter has, for its general office-work, to bind together the parts of our body. Wherever this matter is divided there is a peculiar division in the or-

ganism. This division is peculiar, because it does not affect nutrition or the ordinary organic processes. In a limb whose nerves are severed there is a loss of sensation ; there is also a loss of movement ; the limb continues to live, but for all limb purposes it might as well be dead. Nerve-matter, therefore, preserves the higher bodily unity.

In examining this general nerve-function we discover the distinctive tasks of fibers and cells. The fibers convey, while the cells origi-

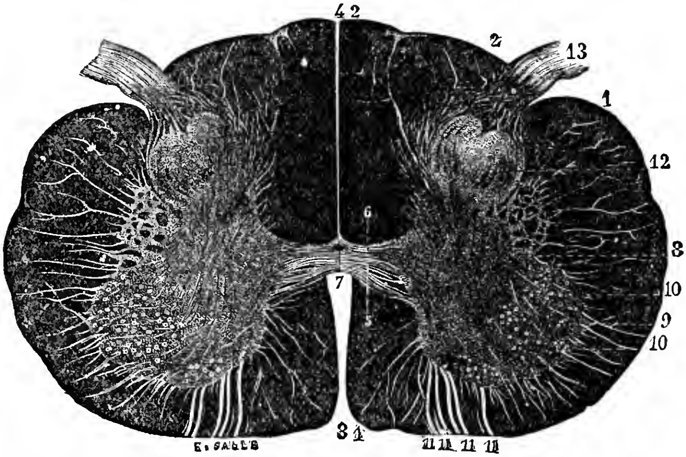

Fig. 5.—Transverse Section through Human Spinal Cord in Cervical Region, showing the organ to be composed of two symmetrical halves. (Sappey, after Stilling.) The black portions correspond to regions containing longitudinal fibers ; the lighter portions represent the central gray matter and the horizontal roots of nerves ; 5, 6, commissures connecting the symmetrical halves of the gray matter ; 11, 11, 11, anterior or motor roots of spinal nerves coming from anterior horns or cornua of gray matter, in which are numerous groups of large ganglion cells ; 13, posterior or sensory roots of spinal nerves, entering the posterior horns of gray matter. Magnified about eight diameters.

nate, motions. Fibers may convey motions from without inward, or from within outward ; in the former case they are called afferent, in the latter efferent. The nerve-arc is composed of an afferent and an efferent fiber and cell matter. The arrangement of the arc is such that the outer end of the afferent fiber terminates at the surface of the body, the inner end at the cell-matter, while the outer end of the efferent fiber terminates in a muscle, its inner end being also in the same cell-matter. Nothing more than this arc is necessary to produce nerve-action. If an impression be made at the surface of the body, the motion there occasioned is carried by the afferent fiber to the cell-substance ; through this substance the motion is transferred to the efferent fiber, along which it passes to the muscle causing muscular contraction. Since the cell liberates motion, and, being much more unstable than the fiber, liberates motion freely, it often happens that a slight impression at the surface is followed by a very violent contraction of the muscle.

Our nerve-arc is not a nervous system. We need only one additional element, however, to form such a system, and this is an ascend-

ing or "centripetal" fiber which shall proceed to another collection of cell-matter. In the cerebro-spinal system we have the lowest nerve-arc brought into close anatomical relation with the large cell-mass of the cerebral hemispheres, as well as with the lower cell-masses, by ascending and descending fibers.

I am now to indicate the functions of the parts of this system previously described, and first the spinal cord. This organ has two distinct functions—these are transmission of motions and independent nerve activity. As conductor of motions the cord is related to the higher encephalic centers. By transmission of motions from the surface of the body along an afferent fiber to the cell-mass of this cord, and thence to the brain, sensations are made possible. By transmission of motions from the brain along efferent fibers down the antero-lateral columns of the cord to the anterior roots, and thence to muscles supplied by these roots, voluntary movements are made possible. This teaching should be emphasized. We are dependent on the anatomical

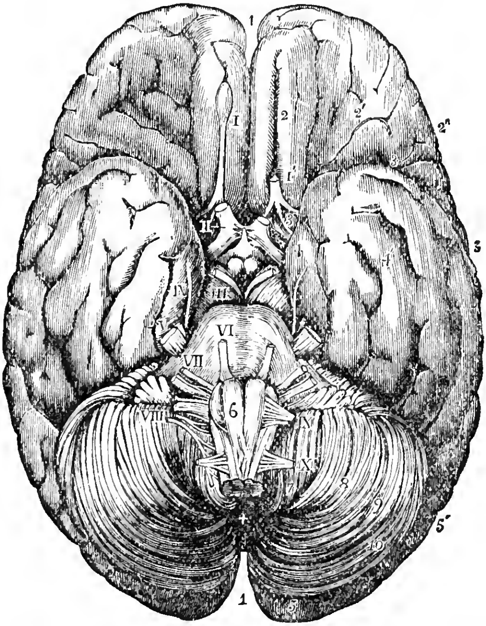

Fig. 6.—Under Surface of the Human Brain. (Allen Thomson.) 1, 1, great longitudinal fissure; 2, 2′, 2″, convolutions of under surface of frontal lobe; 3, 3, 3, prolongation to base of the fissure of Sylvius; 4, 4′, 4″, convolutions of the temporal lobe; 5, 5′, occipital lobe; 6, anterior pyramids of medulla; +, posterior extremity of median lobe of cerebellum; 7, 8, 9, 10, lobules of the lateral lobe of the cerebellum. I-IX. Cranial nerves, all but the first more fully seen in the next figure. The ninth nerve of the right side has been removed. X. First cervical nerve.

integrity of the spinal cord and encephalic centers for any direct sensation, knowledge of things affecting nine tenths of our body, and also for any exercise of volition upon these parts of our body. Consciousness and volition, as far as they relate to any direct connection between ourselves and a large part of our physical organism, are entirely con-

ditioned by nerve-matter, and by the special adjustments of this matter found in the spinal cord. It is interesting to remember, in this connection, that the motions which may be the occasion of sensation are carried to the posterior roots of the cord, while those motions which result in movements are carried to the anterior roots of this organ.

These roots are the crescentic-shaped arrangements of cell-substance before described. The functions of the cord are not limited to transmission. The cord is the source of independent or reflex activities. The peculiarity of these activities is that no consciousness and no volition accompany or occasion them; they are strictly motions. In swallowing food we have an illustration of these reflex activities, and of their close succession to activities that were both conscious and voluntary. Consciously and voluntarily the food is carried to the fauces; at once, the excitation made by the food upon the afferent nerves is carried to the cord and the medulla oblongata; here force is liberated and sent along efferent nerves to the muscular walls of the œsophagus. These walls contract, and the food is passed on into the stomach.

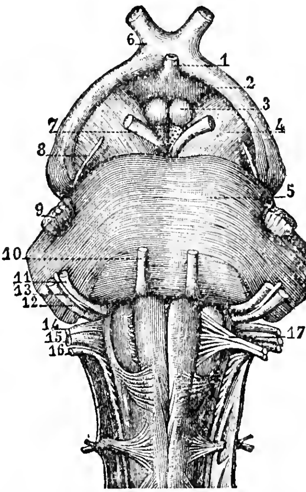

Fig. 7.—Under Surface of Cerebral Peduncle, Pons and Medulla, showing Connections of the Cranial Nerves. (Sappey, after Hirschfeld.) 1, infundibulum of pituitary body; 2, part of floor of third ventricle; 3, corpora mamillaria; 4, cerebral peduncles; 5, pons; 6, optic nerves, crossing in the middle line so as to form the chiasma; 7, common motor nerves of eyeball; 8, nervus patheticus; 9, trigeminus; 10, external ocular nerve; 11, facial nerve; 12, auditory nerve; 13 nerve of Wrisberg; 14, glosso-pharyngeal nerve; 15, vagus or pneumogastric; 16, spinal accessory; 17, hypoglossal nerve (cut away on one side).

When the cord is broken, those parts of the body which lie below the break will move violently upon irritation, though they can not be moved by any effort of will or be known by any sensation. Many actions, not at first reflex, become so by repetition. Walking is a good example: the movements are learned slowly, and upon numerous efforts; afterward, the work is performed by the centers of the spinal cord, so that walking is really hindered by conscious volition. Dr. Carpenter mentions the case of a shoemaker who was subject to sudden loss of consciousness; at such times he always continued the work he was engaged in when consciousness left him; if walking, he would walk into water or fire; if using his awl, he would continue doing so, frequently to his serious injury.

While this reflex action of the cord may thus take place apart from the brain, the brain exercises a strong inhibitory influence over the action. Some persons, by sheer force of will, can hold their feet still under constant tickling of the soles. The following experiment seems

decisive in the matter: A frog is suspended by the head, and his legs are allowed to dip into a vessel of dilute acid. After some time the irritation causes the legs to be removed. The average time is ascertained by frequent trials—then the animal's cord is cut just below the medulla. The time which now intervenes between contact with the acid and withdrawal of the limbs is much shortened, and the action is decidedly more vigorous. Setschenow's experiments (1863) show that this influence of the brain-centers can be greatly augmented by direct irritation of the optic thalami. The rule respecting the reflex activity of the cord would lead us to expect an increase of the activity upon an increase of stimuli. This is true in general, but Wundt has proved that the rule applies to those stimuli only that are carried to the same part of the cord. If an afferent nerve in some other portion of the body should be irritated simultaneously with the cord, reflex action would entirely cease.

We are now to consider certain activities of the cord which are the most remarkable of all its manifestations. I allude to the experiment first performed by Pflüger. This experiment has been frequently repeated and variously interpreted. Pflüger decapitated a frog, and then placed some acetic acid on the animal's thigh. This headless creature immediately wiped off the acid with the bottom of the foot

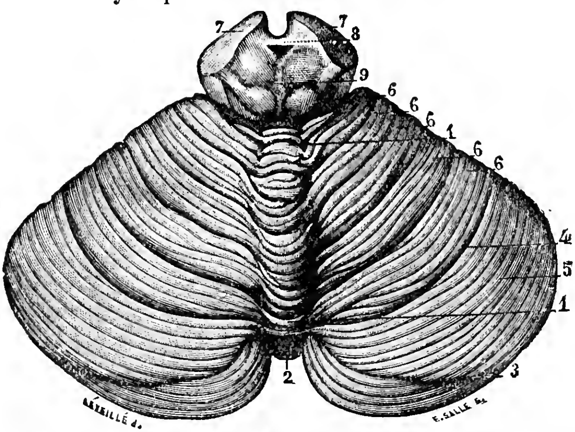

Fig. 8.—Upper Surface of the Cerebellum. (Sappey. after Hirschfeld.) 1. 1, superior "vermiform process" (middle lobe) whose anterior extremity has been pushed backward in order to show the corpora quadrigemina; 2, posterior extremity of the superior and inferior "vermiform processes," and of the median fissure of the cerebellum; 3, great circumferential fissure; 4, great fissure of the upper surface which divides it into two principal segments; 5, posterior of these segments in the form of a crescent; 6, 6, 6, 6, 6, anterior segment, quadrilateral, and composed of five secondary curved segments like the preceding—each of these segments being composed of closely packed "laminæ" of different sizes, separated by fissures of varying depths; 7, 7, sections of the cerebral peduncles; 8, ' posterior commissure" of the cerebrum; 9, corpora quadrigemina.

of the same side. Pflüger then removed this foot and again placed acid on the same thigh. The animal at first, as though deceived, endeavored to rub away the acid in the same way as before. This being impossible, the frog soon ceased trying that method, and seemed to be seeking out some other plan. Finally, he made use of the foot which

was left, and actually succeeded in removing the acid. Pflüger was so astonished and impressed by his experiment that he declared the spinal cord to be possessed of sensory powers—that is, capable of consciousness. I have stated this experiment in detail because it is the most striking among the many facts which have led to such a conclusion as that of Dr. Hammond in his address at Lehigh University, in October of last year. The address may be found in the November number of "The Popular Science Monthly." Dr. Hammond writes, "Suffice it to say that these experiments all go to establish the fact that the spinal cord, after the complete removal of the brain, has the

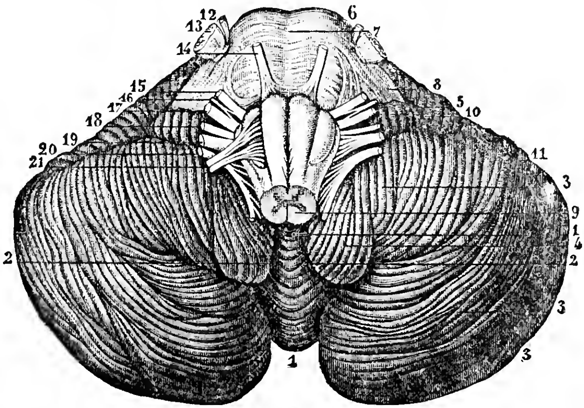

FIG. 9.—INFERIOR SURFACE OF THE CEREBELLUM. (Sappey, after Hirschfeld.) 1, 1, inferior vermiform process; 2, 2, median fissure of the cerebellum; 3, 3, 3, lobes and lobules of the cerebellar hemispheres; 4, "amygdala," or almond-like lobe; 5, lobule of the pneumogastric; 6, pons Varolii; 7, median groove on the same; 8, middle peduncle of the cerebellum; 9, cut surface of medulla; 10, anterior extremity of the great circumferential fissure; 11, anterior border of the upper surface of the cerebellum; 12, motor root of the trigeminal nerve; 13, sensory root of the same; 14, nerve of the external ocular muscle; 15, facial nerve; 16, nerve of Wrisberg; 17, auditory nerve; 18, glosso-pharyngeal nerve; 19, pneumogastric nerve; 20, spinal accessory nerve; 21, hypoglossal nerve.

power of perception and volition, and that the actions performed are to all intents and purposes as perfect of their kind as they would be were the brain in its place." Though Dr. Hammond does not mention Pflüger's experiment, he cites other instances to the same effect. He has seen "the headless body of the rattlesnake coil itself into a threatening attitude, and, when irritated, strike its bleeding trunk against the offending body." Perrault reports that "a viper whose head had been cut off moved determinedly toward its hole in the wall." Neither these instances, nor the others which Dr. Hammond names in this connection, are as striking as Pflüger's experiment. The noticeable feature in this experiment is the fact that the muscular movements which appear upon irritation of the afferent fibers seem not merely to display a *general* conformity to ends, but to adjust themselves to changed conditions. Lotze, remembering the *involuntary* course of acquired movements in man, says, "These actions which point to a consciousness may be simply the back-workings of consciousness upon the mechanism of the reflex organ." Wundt thinks that, "if with Darwin we

acknowledge the inheritance of physical dispositions, we may consider these frog activities as properties of the central mechanism wrought out during the entire development of the species, and inherited by the given individual." That either of these opinions is more reasonable than the one of Dr. Hammond, I think there can be little doubt, especially after witnessing the experiment performed by Goltz in 1869. Goltz took two frogs and decapitated one and blindfolded the other; this was done to prevent any voluntary motions that might arise on account of visual impressions. Goltz then placed both animals in a vessel of water and gradually raised the temperature. Both frogs kept quiet until the temperature rose to 25° centigrade; at this point the frog whose brain was uninjured showed signs of discomfort; as the heat increased he tried to escape, and died at 42° C. During this entire time the other frog sat perfectly still, and gave *no* evidences of distress or pain. But—and here is the significant fact—this same animal, while in the water, made all the reflex defensive efforts when acetic acid was applied to the surface. Aside from these activities, it was still, and died at 50° C. If we admit that the mechanism of the cord possesses the possibility of self-regulation, an admission made by Dr. Hammond in the article from which I have quoted, all these phenomena may be regarded as simple reflex activities. We may accept Dr. Maudsley's judgment that "the reflex activity of the spinal cord is entirely a physical process, which is nowise prevented from taking place because it is not accompanied by consciousness."

Anatomy teaches us to expect complexity of function as we ascend from the cord to the cerebral hemisphere; experiment and pathology confirm our expectation. The medulla oblongata, like the cord, conveys motions to and from the higher centers; further it is the seat of many reflex activities which are indispensable for the organic processes, and further still, it is, in some of these processes, a self-dependent center of innervation. I name the more important activities of the medulla. This organ is the center for respiration. The excitation of this center is brought about in part automatically by the blood. The decrease of oxygen and accumulation of oxidation products in the blood stimulate this part of the medulla, so that respiratory movements may continue after all the afferent nerves connected with the center have been divided. This respiratory mechanism, though truly reflex, is, to a considerable extent, under the control of the will, thus enabling us to articulate for all forms of vocalization.

The medulla is a center of innervation of the heart. Though the heart will beat if completely severed from the cerebro-spinal system, and, in the case of cold-blooded animals, if removed from the body, still its action is decidedly affected by the fibers which unite it with the medulla.

Again, the blood-vessels are brought under the control of the medulla by the vaso-motor center. The vaso-motor nerves pass by the

spinal cord to the blood-vessels through the ganglia and fibers of the sympathetic system. These nerves, being constantly active, maintain a tonic contraction of the arterial walls.

The medulla is a center for the movements of chewing and swallowing. This center can be excited in a reflex manner, and by the will, but not automatically. There seems to be good evidence that the medulla is a center for combined or co-ordinated movements of the body. Wundt is of opinion that the collective motor-fibers of the body are brought into closer union with each other in this organ. His opinion rests upon the fact that, as long as the medulla is intact, sensible excitations occasion general movements of the body much more easily than when this organ is destroyed.

The question now arises as to the relation between the medulla and consciousness. I do not think we are justified in supposing that consciousness appears in connection with this portion of the nervous system. It is a fact that a frog, having simply the cord and medulla, will react not only in the manner already described, but also by movements of the entire body, away from the source of trouble; the animal may even utter a cry as if in pain, yet he may be "merely a non-sentient, non-intelligent reflex mechanism." We know that the medulla is the last portion of the nervous system to come under the influence of anæsthetics. Persons submitting to severe surgical operations frequently cry out violently, and as if in intense pain; yet they assure us afterward that they were not conscious of suffering.

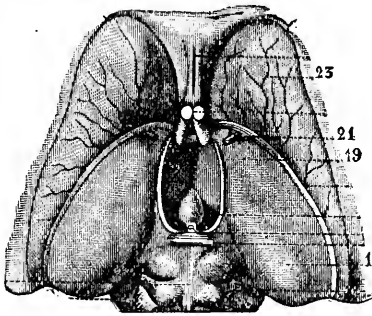

Fig. 10.—Thalami and Striata. (Sappey, after Hirschfeld.) 18, posterior tubercles of the thalami; 19, anterior tubercles of same; 21, veins of the corpus striatum; 23, corpus striatum.

It is common to cite, as Dr. Hammond has done in the article before mentioned, those human beings who are born without a cerebellum or cerebrum, but who perform such actions as breathing, sucking, swallowing, and crying. In these cases the spinal cord and medulla oblongata are well developed. Why consciousness should be ascribed to the activities just named it seems difficult to understand, especially when we consider that similar activities can be produced by a machine constructed for the purpose. To say that, "if these activities are not indicative of the existence of mind, we must deny this force to all human beings on their entrance into the world," is a singular declaration—what would be the harm of such denial?

Most human beings on their entrance into the world have the higher cerebral centers, yet they are so soft and undeveloped as to make it doubtful whether consciousness even then appears; certainly it does not except in most elementary form. We have now to inquire respect-

ing the functions of the pons Varolii. Section or irritation of this organ is followed by powerful movements, and much more pronounced signs of pain than any previously manifested. If we cut the anterior portion of one side of the pons, movements will be produced on the opposite side of the body, and the vertebral column will bend toward the side of section. It has been shown that the deeper posterior parts of the pons are made up of transverse fibers connecting the two lobes of the cerebellum, and we find, as we should expect, that injury to one side of this portion of the organ causes the same rolling movements as appear upon one-sided injury to the cerebellum.

If we remove all the encephalic centers above the pons, the animal so treated will maintain his upright position, will give cries quite characteristic of pain, and will bring about conjoined movements of flight. These manifestations disappear completely after removal of the pons, and we have left only those reflex activities already shown to be de-

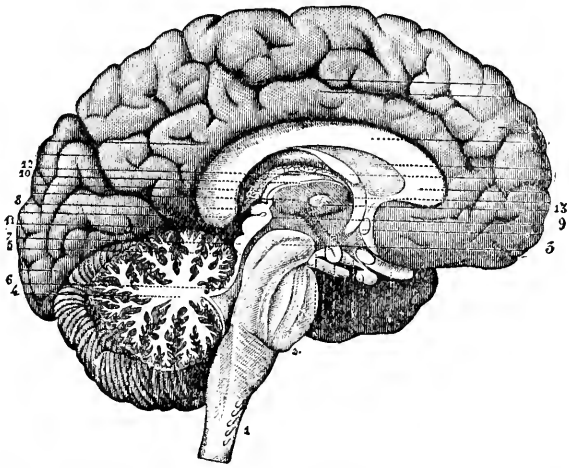

Fig. 11.—Longitudinal Section through the Center of the Brain, showing the inner face of Left Cerebral Hemisphere. (Sappey, after Hirschfeld.) 1, spinal cord; 2, pons Varolii; 3, cerebral peduncle; 4, "arbor vitæ" of cut surface of middle lobe of cerebellum; 5, Sylvian aqueduct; 6, valve of Vieussens; 7, corpora quadrigemina; 8, pineal body; 9, its inferior peduncle; 10, its superior peduncle; 11, middle portion of the great cerebral cleft; 12, upper face of the thalamus; 13, its internal face, forming one of the walls of the middle or third ventricle.

pendent upon the cord and medulla. It seems clear that in the cell-masses of the pons the movements essential for locomotion, for maintenance of upright position, and for expression of pain, are combined. These phenomena have led many physiologists, among them Longet, to consider the pons as a sensorium commune, or the place where the sensations are assembled, and where the movements caused by sensations arise. Other physiologists, among them J. Müller, believe that the pons is the seat of the power of volition. I would reserve my opinion as to the relation between this organ and consciousness until after the functions of other nerve-masses between the pons and cerebral hemispheres have been considered.

The transverse fibers of the pons Varolii unite the lobes of the cerebellum, and we may appropriately consider the functions of this organ before those of the smaller masses within the cerebral hemispheres. There is, perhaps, no subject in nerve-physiology more obscure and difficult than this one of the functions of the cerebellum. The earlier opinion, that this organ is connected with the sexual appetite, has long since been completely disproved. The special difficulty in determining the functions of the cerebellum arises from the disagreement between experiment and pathology, as also from hazard of injury to adjacent nerve-masses. Flourens was the first to investigate the functions of the cerebellum in a strictly inductive manner; his experiments have been repeatedly confirmed, and they must furnish the starting-point for all future inquiry. Flourens says: "I removed the cerebellum of a pigeon in successive slices. During the removal of the first layers there appeared only a weakness and want of harmony in its movements. On removal of the middle layers, the animal exhibited a general agitation, without true convulsions. It made brusque and irregular movements, and continued loath to see and to hear. On removal of the last layers, the animal entirely lost the power of standing, flying, leaping, or walking, which had been gradually affected by the preceding mutilation. Placed on its back, it was unable to rise. Instead of remaining quiet and immovable, like pigeons deprived of their hemispheres, it was in a continual state of restlessness and agitation, but could never make any determinate movement. It could see a threatened blow, and tried to escape, but without success. It made various efforts to recover its station when laid on its back, but utterly failed to do so. Sensation, volition, and intelligence remained, but the co-ordination of movements into regular and determinate movements of progression was entirely lost." There is no doubt that destruction of the cerebellum is frequently followed by striking disorders of equilibrium. Flourens found, however, that these disorders would, in time, be overcome by the animal, even though the lesions were deep. Upon complete destruction of the organ, the disorders were lasting. Weir Mitchell's experiment, quoted by Ferrier, would not confirm this permanency of the disorders. Weir Mitchell states that he destroyed the functional activity of the entire cerebellum in pigeons who, after some months, recovered "so far as to show only feebleness and incapacity for prolonged muscular exertion, but no real inco-ordination or unsteadiness of equilibrium." Repeated experiments have shown a decided difference of result, according to the character and location of the lesions. If these lesions are made symmetrically on both sides, or if the cerebellum be divided in the middle, from the front backward, there is no important disturbance of equilibrium. If, on the other hand, the central lobe be cut in its anterior portion, the animal tends to fall forward; if in its posterior portion, to fall backward. Lesion in one of the lateral lobes is

followed by a most violent and rapid whirling of the body, the direction being toward the affected side if the injury extends through the entire lobe, but toward the opposite side if the lesion be partial. Comparing these results of experiments with the teachings of pathology, i. e., with diseases of the cerebellum in man, there is an unexpected disagreement. Changes in one of the lobes may occur without any observable symptoms. It is only when there is a thorough wasting of the lobe that we have marked disturbances, and these are not simply connected with movements, they affect the intelligence as well. This fact has been specially noted by Wundt, who refers to the striking example furnished by Combetti's case of the girl Labrosse. This girl was entirely destitute of cerebellum and pons Varolii and yet was capable of voluntary movements, though showing great muscular weakness and lack of intelligence. Bouillard reports the case of Guérin, whose cerebellum was shown to be almost wholly destroyed, "yet the patient could co-ordinate his movements, even being able to walk." It should be observed that in both these cases there was muscular feebleness, shown by the reeling and tottering motions of the persons diseased. It is customary to mention the ninety-three cases collected by Andral, to show that the cerebellum is not an organ for the co-ordination of movements. Professor Austin Flint, of New York, has made a most careful examination of these cases, and has fully established the fact that none of them, save perhaps two, could possibly be taken to have a bearing on the question. Almost all the cases are complicated with diseases in other brain-masses, or exhibit sufficient disorder of movement to confirm the original position. There is a striking fact, first noted by Purkinje, that leads to what seems the most rational conclusion which our present knowledge will warrant respecting the general function of the cerebellum. Purkinje discovered that a current of electricity passed through the base of the head of a healthy person causes dizziness. It is natural to attribute this result to some action of electricity upon the cerebellum, especially in the light of the experiments already described.

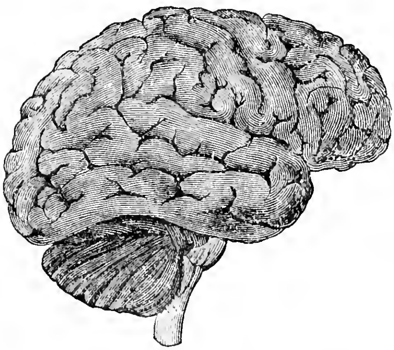

Fig. 12.—Human Cerebrum and Cerebellum, showing the relative size of those parts of the Brain. (After Hirschfeld and Léveillé.)

Dizziness is due to some feeling of change in the relation between ourselves and outward objects. This feeling may be produced by an actual change in the objects or a change in ourselves. Illustrations are abundant, such as rapid riding in railroad-trains or violent swinging. It is a fact of importance in this connection, that alcoholism,

which so constantly exhibits dizziness, is associated with marked disorder of the cerebellum.

In coming to a conclusion respecting the function of this organ, we find that it can not be directly connected with sensation or volition. The sensations appear pronounced and the movements vigorous after destruction of the cerebellum. The marked feature in all deep cerebellar disorders is the maladjustment of muscular actions to the preservation of equilibrium and to harmonious movements. The consciousness of a normal relation between the person and the external world seems overthrown, the violent activities which ensue being plainly attempts to restore this lost feeling. Movements which are voluntarily initiated must be brought into relation with the position of the body in space. The cerebellum is the organ specially concerned with this work. The regulation of all activities that are willed depends upon this feeling of the accustomed relation between ourselves and objects. The cerebellum, in some unknown way, makes the preservation of this feeling possible.

It should be distinctly borne in mind, however, that this conclusion does not necessitate the further one that the cerebellum is itself a seat of consciousness, not even of this consciousness of normal relation. Consciousness may be *entirely* conditional upon the activities of the cerebrum, while at the same time this feeling of relation may depend upon the cerebellum. My meaning is that, though consciousness have its sole physical antecedent in the cerebrum, the special form of consciousness now under consideration may be impossible of origination in the cerebrum without the anatomical and physiological integrity of the cerebellum. Before examining the evidence concerning the functions of the cerebrum, a few words should be said with regard to the optic lobes or corpora quadrigemina, the corpora striata, and the optic thalami. The optic lobes are central organs connected with vision. There seems no sufficient reason to doubt the results of experiment as stated by Ferrier: "The more prominent effects of destructive lesions of the optic lobes in the various animals seem to be blindness, paralysis of irido-motor and some oculo-motor reactions, disorders of equilibrium and locomotion, and in frogs, and apparently in other animals, annihilation of certain forms of emotional expression."

If the higher brain-masses be removed, animals show reflex reactions to rays of light, and, more than this, they display other bodily movements evidently due to the influence of light. According to Longet, birds will follow a burning candle with their heads, and frogs that have been startled into movements of flight by irritation of the skin will avoid objects placed in their way.

These lobes are exceedingly sensitive to electrical stimulation, and the results vary as the electrodes are placed on the anterior (nates) or posterior (testes) eminences.

Stimulation of the nates causes wide dilatation of the opposite

pupil, the head turns in the direction of the eyes, and the ears are thrown back.

When the testes are stimulated, the same results follow, but with the striking addition that, upon the least touch of the electrodes, cries are produced which change from a brief bark to all kinds of sounds as the stimulation is continued.

The opinion has been held by many, and is explicitly stated by Austin Flint, that "the optic lobes serve as the sole centers presiding over the sense of sight, and not merely as avenues of communication of this sense to the cerebral hemispheres." When Flint gives as "posi-

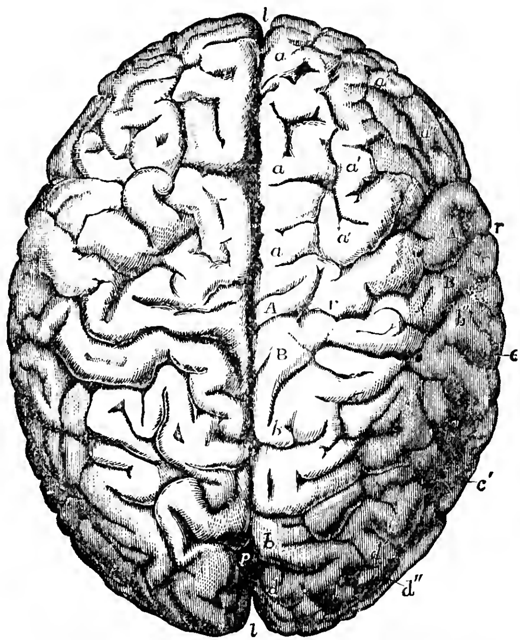

Fig. 13.—Brain of Gauss, the celebrated Mathematician and Astronomer, upper aspect. (Sharpey, after R. Wagner.) *l l*, longitudinal fissure; *a*, *a'*, *a''*, upper, middle, and lower frontal convolutions; A, A, ascending frontal convolution; *r*, *r*, fissure of Rolando; B, B, ascending parietal convolutions; *b*, *b*, parietal lobule; *b''*, supra-marginal lobule; *c*, *c'*, first or upper temporal convolution; *p*, perpendicular (or parieto-occipital) fissure; *d*, *d'*, *d''*, upper, middle, and lower occipital convolutions.

tive" proof of his conclusion the statement that "the sense of sight is preserved after complete removal of the cerebrum," he shows how easily it is possible to give, as proof of a conclusion, the conclusion itself. The thing to be determined is, that the actions displayed after removal of the cerebrum are accompanied by any form of consciousness. While it can not be shown that they are not, it is equally impossible to show that they are. The conclusion of Wundt may be the correct one, viz., that these activities are no more designed or conscious than those reflex movements which we know to be produced by the spinal cord.

As to the functions, in detail, of the optic thalami and the corpora striata, hardly anything is known. It will be remembered that these bodies are the rather large masses situated in the chambers of the cerebral hemispheres. There is no reasonable doubt, however, that they are concerned with sensations and motions; the thalami having to do with impressions which are the physical antecedents of sensations, and the striata with the execution of movements. This conclusion is confirmed by pathology. Disease of the striatum is followed by paralysis on the opposite side of the body. Disease of the thalamus, while not always so uniform in its testimony, does still, sometimes, give striking evidence of a sensory significance of the organ. It should be distinctly borne in mind, when speaking of these bodies, that paralysis of sensation and of voluntary motion may be produced by lesions in the cell-matter of the cerebrum apart from any injury to the thalamus and striatum; it should also be remembered that destruction of these basal ganglia breaks the connection between the cell-matter of the cerebrum and the surface of the body, so that the cerebral hemispheres can not perform their functions. It may, therefore, be true, as many maintain, that these organs are not at all directly associated with consciousness, their function being to adjust the connections of sensory and motor fibers with the cerebrum. This general conclusion need not be taken as supporting the fanciful opinions of Luys. Luys believes that in the thalami sensorial impressions "are for the first time condensed, stored up, and elaborated by the individual action of the elements that they disturb in their passage. It is thence that they are launched forth into the different regions of the cortical periphery (cell-matter of the cerebrum) in a new form, intellectualized in some way to serve as exciting materials for the activity of the cells of the cortical substance." According to the same writer, the striata do for our volitions the exact reverse of that which is done by the thalami for our sensory impressions. "It is in the midst of the tissues of the striata that the influence of volition is first received at the moment when it emerges from the psycho-motor centers of the cerebral cortex. There it makes its first halt in its descending evolution and enters into a more intimate relation with the organic substratum destined to produce its external manifestations—in one word, materializes itself." There can be no doubt about the justice of describing this conclusion as fanciful and quite beyond the data.

We have outlined the structure of the cerebro-spinal system, and have stated what may fairly be set down as established concerning the functions of this system up to the cerebral hemispheres. With respect to the presence of consciousness in the parts already examined, it is plain that opinions radically differ. Some maintain that consciousness is not manifested apart from the action of the cerebrum, that all nerve-activities below this organ are reflex, their only distinctions being in the matter of complexity. Others are equally positive that conscious-

ness accompanies all nerve-actions, while still others assert that certain organs below the cerebrum—viz., the pons Varolii, cerebellum, optic lobes—form a sensorium commune where consciousness in some form appears. It is my opinion that this last conclusion has not, as yet, been established or refuted. I regard it as the most rational of the three in the present state of knowledge. If we accept it, we must recognize at the same time a distinction between elementary consciousness and the full consciousness of an intellectual operation. Many facts in every one's experience bear out such a distinction. We are often conscious without knowing the object or occasion of consciousness; being half-aroused, we feel rather than perceive. It is possible, and from the evidence it is even probable, that provision for this rudimentary consciousness is made by the nerve-masses between the medulla and cerebrum.

Whatever conclusion we adopt respecting this matter, the significant fact remains that consciousness is certain to appear in connection with nerve-matter; sooner or later the question of a strictly materialistic interpretation must be faced. After ascertaining the present state of the case with regard to localization of functions in the cerebrum, the induction must be drawn as to the nature of the relation between nerve-matter and consciousness. Grant that this induction shall be more or less a speculation, we need, I think, to remember that all reasoning is speculative, from the nature of the case speculative, and that the only distinction between credulity and reasoning is this, that credulity is both beyond the facts and contrary to the facts, while reasoning is beyond the facts but *according* to the facts.

CHOLERA.

By Dr. MAX VON PETTENKOFER.*

III.—MODES OF PROPAGATION (*continued*).

THE same considerations hold good in India. The famous places of pilgrimage, whose sanctuaries are annually visited by many millions of individuals, always have some cases of cholera among them; but it is only occasionally that an epidemic breaks out, and then it is only at those times when the predisposition to cholera exists—periods, be it noted, which do not for the most part coincide with the time when the number of pilgrims is at its greatest, nor when the principal feasts are in progress. For instance, Bryden has drawn up tables showing the number of admissions into the hospital at Puri in the neighborhood of the sanctuary called Jagganath for the years 1842 to 1866, and these statistics show the number of receptions of cases of cholera

* Reprint of a special translation made for the London "Lancet."

for each month of the year. This journal, extending over so many years, must give a good idea of the frequency of cholera in pilgrimage, even though the numbers be but small. The principal feasts, when the chariot of the deity is drawn over the breasts of the faithful, occur in the middle of March, but the period at which cholera is at its height is in June, when the number of pilgrims assembled is much smaller. Altogether there were three hundred and thirteen cases in March during twenty-five years, while the number was eleven hundred and fifty-five for June—or nearly four times as many admissions for cholera into the hospitals. Puri lies on the southwest border of the territory where cholera is endemic, and has the same rhythm so far as cholera is concerned as Madras. Hardwar lies in the northwest of India, where the chief feast occurs in April, the principal day being the 12th, and often hundreds of thousands of pilgrims, if not millions, stream together here ; yet cholera only breaks out in an epidemic form when the regions are predisposed to it. It will be interesting to go further into detail on this question. Hardwar is situated about one thousand feet above the level of the sea, where the Ganges quits the Himalayas, and belongs to the holiest of places which the Hindoos worship. Cholera only occurs occasionally in an epidemic form. In the last century (1783) a severe epidemic was known to have occurred among the pilgrims at Hardwar. From 1858 to 1867 the feasts passed on without the occurrence of any epidemic of cholera, and this immunity was believed to be due to the soundness of the arrangements which were enforced by the Government. In 1867 the whole prophylactic armor was thrown aside. But already in November, 1866, an epidemic of cholera was approaching the neighborhood of Hardwar from Agra. The pilgrims began to arrive at Hardwar on April 1st. On April 3d the majority had assembled, although the stream of pilgrims continued to increase till the 12th. The whole number of pilgrims reached about three million. On April 9th the first case of cholera was detected by Dr. Kindall, and taken into hospital. Other cases soon followed. On April 12th, on holy-day, the pilgrims bathed from sunrise to sunset in the Ganges, in a holy fort which is separated from the torrent of the river by a rail, so that the people could not be drowned. Through this fort there was an incessant movement of men all day long. The water became thick and muddy, partly from the ashes of the dead which the pilgrims had brought with them to strew in the stream, and partly from the washing of the clothes and persons of the bathers. Every time a pilgrim entered the holy fort he dipped himself three times under, drinking the water and saying his prayers. The drinking of the water was never forgotten ; if two or more members of a family bathed together, each one drank from the palm of another's hand. All these things happened every year for eight years without ill consequences. But in 1867 a violent epidemic broke out among the pilgrims. Macnamara, a believer in contagium

and in the drinking-water theory, speaks as follows: "On the night of April 11th and on the following day a severe storm burst upon the unsheltered multitude. Only those who know what a storm on the mountains in the tropics is can have any conception what a night of misery these three millions of people suffered on the open plains of Hardwar. This fall of rain must have washed the contents of the closets and the filth on the surface of the earth into the Ganges." And Macnamara believes that on April 12th the pilgrims drank cholera from the Ganges; but Macnamara is wrong. Granted that the storm had really washed the cholera-stools into the Ganges, then the stools must have remained either in the river itself or else in the holy fort, just as was the case in Koch's water-tank. It is true I can find no numerical observations concerning the rapidity of the flow of the Ganges in Hardwar; but if we suppose that its rate is like that of the Seine in Paris at low water—i. e., half a foot per second—then the water would move at the rate of 1,800 feet an hour. The railed-off fort in which the pilgrims bathed is 650 feet long by thirty feet wide, and if the bathing lasted twelve hours, and if only a third part of the pilgrims had bathed, then more than 83,000 persons must have hourly passed through the water; this was impossible, so that only a small proportion of the pilgrims could have bathed on April 12th. These places of pilgrimage are also colossal markets and great places of business. It does not support the drinking-water theory to assume that, during the bathing of the 12th, cholera bacilli did not get into the holy fort from cases of cholera which would hardly be in a condition to bathe, but from cases of diarrhœa. Either a few of the bathers were, to start with, infected, and so large numbers could not be infected until the bacilli had become distributed, or, if a large number were infected at the outset, we naturally inquire where the infection was taken, and whether there was no possibility of their having been infected before going to the bath. While I do not believe that the pilgrims drank death from the holy stream, yet I shall not maintain that the stormy weather had nothing to do with the cause of the epidemic. Cases of this kind have occurred outside India, as in Malta and Spezia in Italy, where a sudden storm has sent up the death-rate in an explosive fashion. But if a weather-storm can create a "cholera-storm," then the cholera must be existent in the soil. One is reminded by this invasion of cholera of the clouds of dust which the watering-carts raise in summer. If the earth is very dry, the water not only lays but makes dust. I can conceive how a sudden heavy fall of rain may rapidly drive out the infective stuff contained in the soil. But Hardwar had experienced bad weather in other years on the same days in April without being followed by such evil consequences.

How does the journey of the pilgrim act in the spread of cholera? That infection can occur in a short space of time is witnessed in soldiers on the march. A case from Bryden's work may be quoted. In

March, 1857, the Sixty-sixth Ghorka Regiment marched simultaneously in two divisions about seventy English miles apart, from the plains to the hill-stations along the Himalayan heights—the A division toward Almorah, the B toward Lohnghat—and both wings, though free from cholera at starting, became infected *en route*. The A division, 611 men strong, arrived on the 13th of March, free from cholera, at Tarai, a narrow strip of land between the plain of the Ganges and the Naini Valley. Tarai is notorious for its fevers and cholera, while the Naini Valley is celebrated for its general salubrity and its remarkable freedom from epidemics of cholera. The division left Tarai the morning after its arrival, passed into the healthful Naini Valley, and halted at the hill-station of Almorah. The first case of cholera showed itself in the Naini Valley twenty-four hours after the first opportunity for infection. The first fatal case occurred on March 16th, two deaths occurred on the 17th, ten on the 18th, nine on the 19th and one on the 22d. These numbers show a mortality of nearly ten per cent. The B division was 361 strong, and passed through Tarai about a week after the A division, remained there but one day, and reached Lohnghat on the 23d of March. The first fatal case occurred on March 21st, while the division was still in Tarai; there were two fatal cases on the 22d, eighteen on the 24th, eight on the 25th, one on the 26th, and one on the 27th. Fatal cases thus occurred within a period of seven days. Such statistical facts, which might be multiplied, have as much value, as direct experiments, as infection through the linen of cases of cholera. It is strange, however, that most of the "cholera linen" first originated in the Naini Valley, in Almorah and Lohnghat, where the disease did not spread further, and where certainly disinfection by carbolic acid or corrosive sublimate was not thought of. But the contagionists have no eyes for such facts. Just as was the case with the Ghorka regiments, so was it with the pilgrims at Hardwar. On April 15th the great mass of the pilgrims—who had been quartered on a flat, partly marshy tract of land, about a square mile in extent, for several days—broke up and departed, so that a stream of 3,000,000 infected individuals for the most part, notwithstanding the influence of the bathing in the Ganges, reeking with filth, began to spread abroad over all India. According to the contagionists, an epidemic of cholera ought to have broken out in every place to which the wandering pilgrims came. In my view, epidemics may break out only where the time and local conditions are favorable; and where these conditions do not exist an epidemic is impossible, as the case of the Ghorka regiments proved. Bryden expresses himself in the following terms on the Hardwar cholera: "From all accounts which have been written concerning the outbreak at Hardwar, the impression is gathered that the epidemic was by no means a typical one. That is only the case, however, if the facts are considered in the light of preconceived theory. For those who search the statistics the facts come out in their true

light, and prove that the type of an epidemic has nothing to do with the smallness or largeness of the number of people affected. The suppression of the cholera at Hardwar toward the east and south and the increase of it in the west and southwest are inexplicable phenomena [Bryden ought to have said, for the contagionists]. But the phenomena are not difficult to understand if the preconceived theory be laid aside. If we take Hardwar as the central point at which the gathering on April 12th was infected, then it will be found that the pilgrims died only in those districts which were reached within a limited time after their daily march had begun. The great majority of fatal cases did not occur at Hardwar, but in those regions which were reached within the first few days after leaving Hardwar. It seems to me that the end of the outbreak at Hardwar was pretty much the same as that of local outbreaks elsewhere, and I can see no connection between the epidemic of cholera in the Punjaub in May and the return home of the pilgrims." The movement the cholera had taken in the autumn of 1866 led Bryden to say, "I believe that the geographical distribution of cholera in 1867 would not have been very different, even supposing that the gathering of the pilgrims had never taken place." And Bryden is perfectly right, for in 1862, for example, the cholera in India became remarkably widely spread without cholera having broken out among the pilgrims at Hardwar.

Such epidemiological facts, which cry aloud for the truth of the existence of local and time predisposition, stand as sure, as etiological elements, as the discovery of a microscopic organism in the intestines of cholera-patients. Only ignorance and prejudice can ignore such facts. It is but a necessary logical conclusion that the comma bacillus, if it have anything to do with the infective material of cholera, must also have some relationship with the local and time conditions which favor cholera. And, further, the relationship must be discovered by the bacteriologists before they can explain an epidemic by the aid of their bacilli and before practical rules can be framed thereon.

Another objection to the views of the contagionists is found in the behavior of cholera on board ships. Long before I announced my views on local conditions, the epidemics of cholera, not only on the rocks of Malta and Gibraltar, but also on ships, were brought as witnesses against my doctrines. What can soil and ground-water have to do with epidemics on ships? And although I had found nothing but confirmatory evidence of my views, still the contagionists remained obdurate. As I can not suppose that all my readers are sufficiently acquainted with my observations on cholera in ships, I must be allowed to give a few illustrations. The contagionists, referring to cases in which epidemics occur during the voyage from Europe and America, say that such can only be explained on the view of infection of one case from another. The facts of such epidemic outbreaks are known to all. How often do such attacks occur? As an instance, I shall

refer to the intercommunication between New York and Europe in the year of cholera, 1873. In that year, according to the register of the offices at New York, there were 760 vessels which arrived from different parts of the world, giving an aggregate of 316,956 individuals, but of these 266,055 came from Europe. Of these, 113,920 came from England, which was free from cholera; from the remainder of Europe the numbers were 152,135, and about 400 vessels served to convey the individuals, making up the last figures, from ports infected with cholera. If we inquire into the statistics, we find that cholera chiefly occurred on four vessels only. Eleven cases were registered from the Westphalia; one fatal case from the Ville du Havre; from the Washington three fatal cases; and from the Holland one fatal case.

Although the chances of contagion aboard ship are very favorable, yet how small was the number of cases of cholera! Take the ship with eleven cases, and we find that they belonged to two German families only; two died during the voyage, nine were landed on Dix Island, and of these but one died and the rest recovered. How is it conceivable that cholera should have confined itself to two families without attacking others? I believe that both families had contracted cholera before going on board; indeed, an epidemic may occur in a ship provided the passengers have all come from a place where cholera exists. The contagionists have, however, replied that some remarkable epidemics have happened on board ship, which could not be explained on the above-mentioned view. It is a question whether cholera can infect on board ship. The contagionists take facts conveniently; they select those instances which occur least frequently and adopt them, to the exclusion of the great majority of instances which tells against them. I recall the articles which I wrote in the "Vierteljahresschrift für öffentliche Gesundheitspflege" and in the "Zeitschrift für Biologie" to prove that I have thoroughly investigated the nature of epidemics of cholera on ships. Rumors of false returns concerning cholera on board ship have been bruited. But these falsifications can hardly be committed when an epidemic occurs during a voyage. It may be said that my instance of 1873 does not disprove the contagiousness of cholera. Cholera, like small-pox, does not attack every one who is brought into relationship with it. If even a few instances of contagion were proved to have occurred on board ship, we should have to admit the contagiousness of the disease.

I do not doubt that instances may exceptionally be found among infectious diseases in which the behavior is essentially the same as that of cholera on the ships going between Europe and New York. But the question is, How do such cases generally, not exceptionally, behave? Vaccinated persons may be brought into contact with cases of small-pox without fear of infection; and, at times, individuals who have not been vaccinated may come in contact with small-pox without taking the disease. As a rule, however, small-pox on board ship be-

haves very differently from cholera. We shall pass in review an instance of a severe epidemic of cholera on board ship, notwithstanding that it favors the views and theories of the contagionists. The following specimen is chosen, for the reason that it occurred on a man-of-war, and as there are many such vessels the advantage of comparison exists: The Britannia was in the spring of 1852 equipped as an admiral's ship, and was generally stationed off Malta for the first year; in August, 1853, it went to Besika Bay, and in October to Constantinople, where it remained the whole winter; and, after the declaration of war, went in March, 1854, to Varna. With the exception of a brief expedition to Odessa and Sebastopol, it remained at Varna all through the summer. In August cholera broke out, and first of all among the troops on shore. The ship and the whole fleet were up to this time perfectly healthy. It was believed that the French had brought the cholera with them from the Dobrudja, whence some regiments had been sent from Varna. A few of these returned, but the majority met with their death either from cholera, typhus, or marsh-fever in the low country of the Danube. After the cholera had begun to subside on land it appeared in the fleet, among which it was, however, unequally distributed. At Varna there were assembled fifty-four ships-of-the-line, belonging to the English, French, and Turkish fleets, without reckoning the smaller craft. The Britannia lay, on August 20th, in the Bay of Cavarna, fifteen miles by water from Varna. About one hundred paces from it were lying two other English three-deckers, the Trafalgar and Queen, both, like the Britannia, manned by 1,040 sailors. The Britannia lost one hundred and thirty-nine from cholera, the Queen and Trafalgar four and six respectively. On the French and Turkish ships it was the same. Strange to say, the French admiral's ship, the Ville de Paris, like the Britannia, was most numerously affected; there were one hundred and sixty-two deaths, of which three were of officers. During the disease the French vessel lay at anchor off the coast with the rest of the fleet. The Britannia went to sea in the delusive hope of staying the course of the disease. That cholera should rage on the Britannia without causing the death of, or even attacking, one of the sixty officers on board, is for the contagionists an inexplicable circumstance. We must now inquire into the reason why cholera was so rife on the Britannia while the Trafalgar and the Queen were so mildly attacked. If the outbreak were due to the presence of cases of cholera, or to the linen from cases of cholera, on the ship, it might be urged that this circumstance was common to all the ships. Dr. Milroy has attempted to explain the epidemic on the notion that it was not due to the specific infective material, but to the individual predisposition to cholera. In the night it was found necessary, on account of the cases of diarrhœa and cholera, to close the hatchways on the lower decks while the ship was at sea. Dr. Milroy says: "The men appeared to be poisoned by the foul air which they had to breathe at night. . . .

A more striking example of the deadly effects of impure air during the period of an epidemic, and of the most infallible means to check the evil, can not be imagined. The immunity of the officers was, on this occasion, unquestionably due to the greater space for breathing purposes which the officers enjoyed." That is an explanation which must satisfy the practical physician. I also believe that impure air is harmful, but I do not think impurity of air sufficient to explain such an explosion of cholera as that above referred to. It must not be forgotten that the Britannia went to sea on account of the general poverty of its hygiene. We ought to inquire into the condition of other ships also attacked with cholera, but in which the hatchways of the lower decks were not shut. My witness, who was on board the Britannia, assured me that the air was by no means so impure as Dr. Milroy made out. Another mistaken notion which I had taken up was also set right. I thought hitherto that the closing of the hatchways of the lower decks was occasioned by the stormy weather. On this point my informant writes to me thus: "The matter was not quite as you seemed to have imagined, and it will perhaps be best if I give a brief description of what actually took place. The day following our departure from Cavarna Bay a calm overtook us, and instead of the desired cool breeze a burning sun poured down on our sick ship. Then there came a swell on the waters, but no wind. In consequence the ship was so violently tossed that the hatchways of the lowest deck, where the crew slept, had to be closed, and then followed the worst night, during which fifty-eight men died, a night without wind, and without the slightest movement of the superheated air. Nothing was said of a storm. If we had but had one! That the shutting of the hatchways had any influence I do not believe; for, owing to the heat, the men were allowed to lie about where they pleased, and most of them betook themselves to the uppermost deck in the free air, and slept on the floor. The physicians had consented to this arrangement, and under the canopy of heaven the bulk of the fatal cases occurred. In this connection it must also be observed that the Ville de Paris, which did not go to sea, yet suffered as much as we did, in spite of the fact that the hatchways were not shut." So much for the explanation which regarded the shutting of the hatchways and the impurity of the air as the cause of the epidemic. The view of the contagionists meets with no better fate. That a cholera-patient should arrive on board with his stools or soiled linen explains nothing, since this circumstance was common to many other vessels without being followed by such consequences. If the infective material were brought in the food and drink on to the Britannia, how is it that only the crew and not the officers suffered? On this point my informant says: "Provisions came daily from the shore, even during the time we were fifteen miles away, but the officers ate the same meat, the same vegetables and fruit as the crew. The only difference was that the crew drank rum-and-water, while the

officers had wine." Thus in the drinking-water no difference obtained. Ballast might have been a vehicle of infection, and for this purpose sea-sand and shingles, and other material, were taken from the shore. But I have been informed that "on the Britannia, as well as other English men-of-war, the ballast consisted only of so-called pig-iron, four-sided pieces, which were wedged together in the lowest part of the vessel, and never touched." We have yet to consider the different habits of the men and the officers while on shore before the outbreak of the epidemic. On this matter my informant writes: "The sufferers, not only of the Britannia, but of the rest of the ships of the fleet, had frequent communication by daily visits with the shore as we lay off Varna, and the crew without doubt betook themselves to those poisonous liquors, and still worse places of pleasure, which had sprung up on shore like mushrooms." It may be understood that the company of one ship would, like men of the same regiment, visit places of pleasure together and imbibe the same drink, and so it might happen that a particular crew visited a certain place where cholera prevailed, while other crews might have unconsciously kept clear of the places from which it is supposed cholera was taken. It remains doubtful whether the infection was derived through the air, water, or food. If these circumstances be viewed in an unprejudiced light, it will be seen that local conditions may account for the infection and spread of cholera on board ships. On emigrant-ships the matter can not be otherwise, and it is necessary, therefore, to inquire into the previous history of those who were taken ill on board. I have shown that the eleven cases of cholera which occurred on the Westphalia, bound for New York from Hamburg, came exclusively from two German families, and that an epidemic as vast as that which befell the crew of the Britannia might be explained, if we supposed that a majority of it came from the same district, or were placed under the same conditions as the two German families prior to their going on board. The exceptional outbreaks on emigrant-ships prove that such an occurrence is possible. That the Britannia, as a ship, was not a place of infection, is shown by the freedom from cholera enjoyed by the sixty officers. These points may possibly be cleared up by the appointment of a commission to inquire into the presence and etiological factors of cholera on board ship during epidemics of cholera. Koch has spoken of the occurrence of cholera on ships, and has attempted to reconcile matters on the basis of his doctrines of contagion. He has studied those ships which ply between North America and Calcutta. This line has not escaped my attention, and I have stated the main facts in my paper on "Cholera in India," 1871. Koch comes to the same conclusions as I did. Of two hundred and twenty-two vessels which made the voyage during ten years, cases of cholera only appeared on thirty-three ships, although they started from a district where cholera is endemic. It appeared to Koch only to be of importance, that cases of cholera continued to occur more than

twenty days on sixteen ships; therefore these cases could not have originated at Calcutta, but must have been derived from infective material on board ship. If cholera is acquired from the infective material on board ship, how is it that the infective matter is, as a rule, so ineffective, and acts only exceptionally? If cholera lasts more than twenty days on board ship, then there must be other causes than those which prevail on land. Let it be assumed that the infective material proceeding from human beings can call forth the disease after the third day and up to the twentieth day. Now, cases of cholera have occurred on board ship as long as forty days after leaving port, of which fact I could give many examples. But these are very exceptional. May it not be assumed that in such cases the infective material might be brought on board and kept effective in some form or other, and that individuals might constantly come in contact with the infecting agent? For exceptional circumstances exceptional causes must be assumed. Properly considered, it will be found that cholera behaves on ships pretty much the same as ague does. When ships leave a malarious district, cases of ague occur on board, but when farther out at sea they cease to occur. As a rule, the illnesses happen only in those individuals who come from shore, though exceptionally the disease shows itself in individuals who have never been ashore. But epidemics of ague have occurred on ships, as Hirsch has recorded in his work on "Malariakrankheiten," where the infection of the crew on shore appears to have been quite impossible, as on a ship which went from an Eastern seaport to England, and yet no one has ventured to say that ague is not dependent on the soil, or that it spreads on ships by contagion from man to man where the people have not been infected on land. The sweat of the sufferers from ague may be likened unto the stools of cholera-patients. If the infectious disease, ague, were as dangerous as cholera, it is not unlikely that many more observations on contagion from cases of fever, and on the presence of ague on ships, would have been made and recorded. Any exceptional occurrence in the way of ague on ships would almost certainly be more likely to be recorded if they happened on men-of-war or emigrant-ships than if they occurred on merchantmen, on the ground that the rare event is witnessed by a large number of men, and because the state of health of men-of-war and emigrant-ships is more carefully registered than is the case with smaller vessels.

A CHAPTER IN FIRE INSURANCE.

By GEORGE ILES.

LAST year was not extraordinary in its fire record. It bore no such calamity in its course as 1871 or 1873, when the nation was called to mourn for Chicago or Boston. Yet there is good reason to believe that during 1884 fires cost the United States $160,000,000. This enor-

mous sum includes estimates of the amounts paid by insurance companies for losses and expenses; of the losses for which there was no insurance; and of the outlay in maintaining fire departments in towns and cities. The devastation by fire during the past year equaled in value the insurable property in, say, so large and wealthy a city as Buffalo. Still more woful than the destruction of property by fire were the sufferings of thousands by bodily injuries, and the losses of hundreds of human lives. Of minor but considerable importance is the prevailing dread of fire which its imminent risk creates—a dread deducting so much from comfort and peace of mind, particularly among the people who work or live in tall and unsafe buildings.

All competent students of the subject are agreed that this tax on life and treasure is largely avoidable—avoidable by care in construction and use of buildings, and attention to tried and proved means of extinguishing fire. The fire-tax is the most onerous one paid by the nation, and it was but natural that the first scientific attempt to reduce it should have been made by a class of capitalists upon whom the cost of insurance was most oppressive.

The textile manufacturers of New England have shown how best the risks, losses, and expenses of fire can be reduced to a minimum. In 1835, when Hon. Zachariah Allen, of Providence, established mutual insurance among the mills of Rhode Island, the rates charged by stock companies varied from $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent. Even at these high figures the business was unprofitable, and the placing of risks often a matter of difficulty. Within the fifty years since 1835, the cost of insurance to the factories of New England has been reduced to two-sevenths of one per cent. This, too, while the ordinary rate of insurance throughout the United States is nearly one per cent on property considered to be on an average less hazardous in character. I will endeavor to state how this result has been brought about.

Principally by full inquiry into the causes of mill fires, which has shown that the three elements of safety are good construction, adequate quenching apparatus, and thorough discipline in its use. Safe construction can not always claim the much-abused term "fire-proof," but it may be practically the same thing, "slow-burning." It need be but little more expensive than the customary bad methods, and proceeds on a few simple rules:

1. Timbers for the frame of both floors and roofs should be made in such solid manner as to burn slowly; all should be open, smooth, with the corners chamfered off.

2. Floors and roofs should be of thick plank, with mortar or sheathing-felt between the planks and boards of floors. No boxed, hollow cornices should ever be constructed.

3. There must be no concealed space under a door, behind a furring, or in a partition, where a fire can lurk out of the reach of water, or where a rat or mouse can build a nest.

4. Elevators, stairways, and other openings from floor to floor should be cut off by properly constructed hatches, doors, or other means, automatic in action, if possible.

5. Openings in party-walls and exposed windows should be protected by wooden doors or shutters, covered with tin, preferably self-acting.

6. Rooms in which special danger exists should be plastered on wire lathing close to the surface of the ceiling, and following the line of the timbers. All iron posts in exposed places, or iron or stone posts, on which the safety of a building greatly depends, should be protected from fire, either with wood or tin, or by wire lath and plastering.

Of materials for walls, brick is best, and sandstone next best. Limestone calcines and crumbles at high temperatures, and granite breaks and cracks most dangerously. When gas is used in lighting a mill, it is proper to have a controlling valve external to the mill, so as to cut off the supply in case of fire. Sometimes gas is carbureted with gasoline, in which case, fifteen minutes before a mill ceases work at night, the uncarbureted gas is alone permitted to be used, so as to take up any liquid deposited in the pipes. When electric lighting is adopted, approved rules for its installation and use must be observed.

Whenever possible, mills should not exceed one story in height. When so constructed, they can be better lighted than lofty buildings, and they are much less liable to costly vibration. This latter source of loss in a mill four or five stories in height may absorb a fifth of the motive power. A one-story mill, in case of fire, is much more safe and manageable than a lofty structure. It is pleasant to find so potent economic arguments against the tendency which, in recent years, has piled up factories so high, and crowded them together so closely.

Steam-pipes, for heating purposes, have been found quite as effective when suspended from the ceiling as when placed upon the floor; while, in the former case, they do not furnish lodgment to cotton-waste, paper, shavings, and other combustible material. Similar refuse is apt to gather dangerously about a steam-pipe rising through a floor —the means of safety here being its inclosure in a cast-iron shield of conical form. Steam-pipes require careful protection from contact of inflammable substances. Of non-conducting covering materials, asbestus, hair-felt, cork, fossil-meal, magnesia, and rice-chaff are the best.

The rules here presented in mere outline are given in detail by Mr. C. J. H. Woodbury, inspector of the Boston Manufacturers' Mutual Insurance Company, in his work on the "Fire Protection of Mills." They are the outcome of the long and varied experience of the Mutual Companies of New England. Of these companies, the one I have just mentioned is the foremost, and I am indebted to its president, Mr. Edward Atkinson, for data included in this sketch. From an analysis of the causes of fires in which his company was interested

during the twenty-nine years ending January, 1880, it appeared that spontaneous combustion had played a leading part. Cotton-waste, saturated with oil, and used for wiping machinery, then carelessly cast into wooden boxes and cupboards, had clearly led to immense losses. Losses quite as serious were traced to the firing of similar materials secreted by rats and mice. This suggested an exhaustive inquiry into the spontaneous combustibility of the oils in common use as lubricants, the Massachusetts Institute of Technology lending its aid in the work. Astonishing were the results—certain popular oils were proved so hazardous that the mills using them had been unknowingly courting calamity. Other brands were found comparatively safe, and a few quite safe. A rule was then adopted by the Mutual Companies prohibiting certain oils from use, and recommending certain others. Generally, mineral oils were approved, and animal and vegetable oils condemned.

The benefit of the inquiry did not cease here, for it suggested to Mr. Woodbury a series of experiments whereby he has determined the value of oils as lubricants. Since friction is one of the main sources of expenditure in the use of motive power, and a noteworthy cause of fire, Mr. Woodbury's reduction of lubrication to a science is a valuable gift to manufacturing industry. His researches were presented to the American Association for the Advancement of Science at its meeting in Boston in 1880, the published proceedings giving his results in full.

Oil is not only a lubricant, and a substance liable to spontaneous combustion, but has an extensive application in wool-manufacture. One of the collateral inquiries instituted by the mutual underwriters on behalf of their clients has led to an immense saving in wool-oils through the exact determination of their comparative efficiency.

Spontaneous combustion, according to Mr. Atkinson's compilation, was shown to occur not only with respect to oil and charred wood, but also in dyeing operations. Certain kinds of coloring-matter enter rapidly into combination with atmospheric oxygen, and reach a dangerously high temperature. Fans employed to produce a strong air-blast aggravate this danger, against which the best safeguard is the use of fusible links melting at 160° Fahr. Thus fan and engine can be automatically disconnected when fire breaks out. Lanterns have to answer for many conflagrations. In the Boston Manufacturers' Company alone, lanterns broken and upset have led to losses aggregating a quarter of a million dollars. Safe types of construction were introduced, soon after the need for them was announced. Another preventable cause of loss came from employing solitary workmen on repairs at night. In cases of fires spreading from sparks, lanterns, cinders or other source, the unaided mechanic could not well exert himself at once to give the alarm and quench the flames. Hence the enactment of a rule that at least two workmen shall execute all repairs

necessary when mills are idle. One of the workmen must be capable of starting the fire-engine and pumps instantly. Most fires occur at night. At other times when work is suspended, and supervision apt to be relaxed, the risk of fire increases. To meet this, comes the obvious suggestion that on Sunday, Independence-Day, Thanksgiving, and Christmas, there should be increased vigilance by superintendents and watchmen.

However wisely designed a mill may be, and however vigilant its employés, it may take fire from causes practically unavoidable.

How flame may best be quenched then becomes the next important question. Apparatus for extinguishing fire, according to the Mutual underwriters, should include :

1. In all possible cases, water-pipes supplied from at least two sources, with two or more fire-pumps ; or one pump and a reservoir of sufficient elevation to give an ample supply of water through its connecting pipes.

2. An adequate pipe-service with hydrants in yards, porches, in all rooms, and upon the roofs. When possible, the water should stand in the hydrants, both in the yards and in the building, from the tank or reservoir.

3. Hose and hose-pipes should be ready for use, and should be attached to the hydrants, with a drip-coupling to take off any water that may leak by the valve.

4. Automatic sprinklers in all parts of a building where there is special liability to fire, and generally in all stories above the second, however occupied, especially the uppermost. Among the appliances of recent introduction for extinguishing fire, the automatic sprinkler deserves special mention from its importance and success. It mainly consists in a plug of fusible metal attached to a water-pipe, which melts off at a moderately high temperature, say 160° Fahr., and permits the issue of a drenching spray. Were not high cost a serious objection, sprinklers might be made controllable, not by fusible alloys, but by electrical levers attached to sensitive thermometers. Any device which shortens the time during which a fire is left to itself is of importance. A fire-alarm is usually applied to the existing automatic systems.

5. Small hose attached at numerous points to the water-pipes in the rooms.

6. A full supply of water-buckets reserved for fire purposes, and always kept full.

For the efficient use of apparatus, a well-drilled fire department is required. Watchmen particularly should be thoroughly trained in the use of appliances for combating flame, and should be familiar with the positions of valves, hose, and buckets. Aid in their work is given by an excellent electric fire-alarm, which is gradually coming into use in the mills of New England. It announces instantly, in both engine

room and office, the point at which a dangerously high temperature or fire exists.

For the protection of city blocks, a system of hydrants and pipes placed on roofs has been suggested; water at an ample pressure to be constantly available. Very solid brick division-walls, carried up a few feet above the roof, are desirable in such blocks.

It may now be in order to state the progress of the mutual system of underwriting, whose methods have been briefly presented. On January 1, 1885, the nineteen associated Factory Mutual Insurance Companies had at risk no less a sum than $375,000,000, an amount nearly twice as large as that at risk seven years before. During these seven years the cost to the insurers in the leading company, the Boston Manufacturers', had declined twenty-three per cent, as compared with the cost during the years from 1850 to 1878. In the early part of this latter period the volume of business was small, and the losses proportionally greater than they afterward became. During 1884 the net premiums paid by insurers in the Mutual companies averaged 28·28 cents per $100 insured.

A few words as to the details of effecting the mutual insurance of factories: Although the cost is currently but 28 cents per $100 per annum, the companies charge rates averaging 80 cents, the difference being returned as dividend. In addition to the payment of premium, each insurer becomes liable for an assessment five times as great as the premium. No such assessment has ever been called for in the history of the Factory Mutual Companies. No policy is granted until compliance with the companies' rules for construction, quenching apparatus, and discipline in its use, has been ascertained by an inspector. His further business is to pay frequent and unannounced visits to insured premises, to see that all is as it should be. Disobedience to rules, or culpable negligence, may be deemed sufficient cause for canceling a policy. When an ordinary mill or factory adopts the means of safety laid down by the mutual underwriters, it is computed that the outlay is saved in premiums in two years.

In the foregoing paragraphs a form of scientific underwriting has been briefly described, which has important bearings on the general question of insurance and the reduction of the fire-tax. New England Mutual underwriters have ample scope for their activity in the pursuit of their business, and are very cautious in pointing any morals to stock-insurance companies. Mutual underwriting is well adapted to the kind of risks it accepts. These are large mills usually isolated. They fall into comparatively few classes, for which rules for construction and fire-appliances can be readily prescribed. Each passing year finds manufacturers more and more alive to the advantages of the mutual system, the last interest which has begun to adopt it being that of the rubber-factories.

Mutual underwriting can not be directly applied to the miscella-

neous and concentrated risks by great cities. It shows a long and honorable record without the levy of a single assessment. Yet what owner of city property, with Boston and Chicago in his memory, would care to become liable for fourteen times the net premium of a normal year?

While the direct extension of mutual underwriting has recognized limits, still its methods afford lessons of utmost value not only to owners of buildings, but to architects and builders. Stock-insurance companies usually accept risks as they find them, and base the rate of a premium on the assumed degree of combustibility. Mutual insurance has taken its chief mission to be the prevention of combustibility, by a judicious co-operation between owner, architect, and builder. It has demonstrated that this co-operation accrues greatly to the owner's advantage in money saved and safety increased. The cardinal principle of mutual insurance is to minimize risk by a strict examination into the causes of fires. This rule should be carried out in every city and town of the Union, by properly appointed officers, clothed with necessary authority. It matters not how petty a blaze may be—its investigation may yield information of immense value. An unsuspected source of danger may to-day burn ten dollars' worth of property, and next month consume a million. An electric current crossing water rendered conductive by a trifling chemical admixture; fine flour-dust diffused in a mill; sparks struck by a wheel or tool of metal—these are among the hazards for which special safeguards have been devised and applied within recent years. There is nothing strange about these hazards, now that they have been pointedly brought into notice. They were simply common neglected matters, until overwhelming disaster showed the necessity of prevention. In small fires or great, investigation into causes should be thorough, that means of safety, if such exist, be ascertained and enforced. Mr. Atkinson is of opinion that fires not preventable need not cost more than one tenth of one per cent per annum of the value of property insured. All beyond that, he holds to be the price of faulty construction, inadequate appliances, and imperfect discipline in their management.

While mutual underwriters have been exploring the essential principles of sound construction, they have arrived at much as applicable to warehouse or hotel as to cotton or paper mill. They have pointed out the risk of gingerbread cornices, hollow floors, and high-pitched roofs. They justly inveigh against the common practice of setting pine Mansards on lofty structures. They give instance after instance where solid party-walls and self-closing hatchways have saved property, by holding a fire within manageable bounds, and keeping it in a horizontal area, where it can be successfully fought. They have determined the best appliances wherewith to combat flame, and how they can be best placed and used. An important principle in the construction of these appliances has been evolved as a result of their labors—

the principle whereby, on the first bursting out of flame, automatic means of safety begin their work. Developed fully, this principle promises to be the most effective known against the incendiary, whose crimes lead, perhaps, to one third the losses by fire. A watchman usually vigilant may be unobservant or negligent at a critical moment. The melting-point of a soft alloy, or the transmission of an electric current, has a constancy which may be depended upon. Fusible links which stop a destructive air-blast, or close a door, window, or hatchway, fusible plugs which control powerful streams of water, are excellent substitutes for apparatus to be started by human agency on detection of danger.

That insurance has increased incendiarism is proved by British statistics. Between 1852 and 1866, the proportions of fires originating in Great Britain from unknown causes rose from $34\frac{1}{2}$ to $52\frac{1}{3}$ per cent. Destruction by fire takes place in a much larger proportion in property insured than uninsured. Incendiarism is of two kinds, that of an interested policy-holder, and that of a malignant criminal. While fires due to the latter may be checked or extinguished by well-planned apparatus, the losses due to the former variety of crime might be to some extent prevented by insurance companies only indemnifying for losses in part. Suppose a merchant to take out a policy by which he is to be reimbursed for three fourths the amount of a loss actually sustained, whether partial or total. Clearly, the company has a better risk than if it granted full indemnity, for now its client has a direct interest in escaping loss by exercise of skill and vigilance. Any means which makes responsibility reside with an owner has a wholesome element of justice and safety in it. Very unbusiness-like certainly is the action of some stock companies which refuse to reduce a premium rate when the insured adopts new means of safety. Such refusal would warrant the impression that any methods whereby the volume of loss by fire would be diminished, and with it the commissions and fees of canvassers and agents, have a sinister interest to oppose them.

The cost of insurance is chiefly due of course to losses; about one half as great, however, are the expenses of the business. Let us turn once again to mutual underwriting for instruction. That system, being uncompetitive, requires neither advertisement nor solicitation. Its expenses are one tenth those of stock insurance. The mutual companies are simply the agents of their policy-holders to provide means of collecting the sums paid for indemnity and the small charges of the business. Stock companies founded, say, in New York, Hartford, or Philadelphia, have agencies throughout the country, actively competing against one another for business. Small cities have often as many as twenty insurance agencies, maintained at high expense in proportion to the volume of transactions. Economy here could be effected by a single local company without agencies, doing as much local

business as it could, and reinsuring a large percentage of its risks in the offices of other cities. By a uniform method of classification, and a uniform responsibility, each of the nineteen New England Mutual Companies reinsures in the other associated concerns. The acceptance of risks is local, their distribution is general. Were pioneer stock companies to adopt this plan, their success would oblige other companies to imitate them. Expert underwriters would be required to plan the details of a scheme applying to miscellaneous risks some principles of mutual insurance. These would comprise :

1. The identification of the interests of owners and insurers by basing rates of premium upon the actual hazard, allowance being made for all precautions against fire, and approved methods of quenching it. By issuing policies to cover somewhat less than the total of a loss, at a lower rate than when full indemnity is assured.

2. By combination of the advantages of a local underwriting with the benefits of well-distributed risks. Companies doing a local business are not subject to the expenses and inefficiency of great companies with agents widely scattered and difficult of control. Reinsurance on a well-considered method will give local companies stability in cases of large fires—this, while the interests of local insurers will always be large enough to make them anxious to have as few and as small fires as possible.

In a large city, where several local companies might occupy the field, each could select its risks from among all quarters of the city. By whatever means attained, one thing is clear, that the business public, pressed by the narrowing margin of profit, will avail itself of the cheapest safe insurance to be had. The reduction of cost must spring from making the prevention of fire the cardinal rule of insurance. At present the main rule is simply to accept risks as they are, and assess immense losses—largely preventable—on the public. In Great Britain, premiums average one quarter those charged in America, and the business is profitable. Why can not America reach this economy, by adopting British care in construction?

Apart from the Manufacturers' Companies, mutual underwriting has not obtained much foothold in the Union. In New York State, in 1883, the assets of the mutual companies were but one per cent in amount of those of the stock concerns. These latter, with large reserves ready at the call of disaster, enjoy a public confidence withheld from the comparatively weak mutual associations, scattered here and there throughout the country. When capitalists, however, become local underwriters on a large scale, we may expect insurance to have a preventive efficiency, such as we find among the New England mills. Just here a quotation from the New York State Insurance Commissioner's last report may be in order :

"During 1883, stock companies doing business in the State lost percentages of premiums received as follows : Those organized in the

State, 45·83 per cent; those organized in other States, 64·06 per cent; and foreign companies, 66·03 per cent." The ratios of expenses parallel these proportions. So much for the saving power of direct interest and control.

The prevalence of wood in American building, arising from its cheapness, has had its effect in promoting combustibility. We are accustomed to hear frequent lamentations of the destruction of our forests. That destruction will bear at least one benefit in its train—a lessened use of wood in building. In European cities, where brick, tiles, and cement largely take its place in construction, fires are infrequent, and not specially devastating. There fire departments may be found in a simplicity which argues an enviable feeling of general security. As lumber grows scarcer from year to year, and money cheaper, we may expect a decreasing combustibility in American buildings. Immunity from loss is bought at its lowest price when a structure is designed and erected with intelligence and liberality; these qualities will have more scope as capital grows more abundant.

In developing sound principles of insurance the mutual underwriters of New England have done notable work. Their inquiries have been marked by a thoroughly scientific method, which has in its range generously included collateral investigations of immense economic value. In the strict line of their researches, while applying justice, economy, and ingenuity to the solution of their problems, they have taught lessons that must produce world-wide good. Their conscientious work, when understood and applied, will inevitably lower the fire-tax, save life, and abate one of the chief horrors of our civilization.

CUMBERLAND SOUND AND ITS ESKIMOS.

By Dr. FRANZ BOAS.*

SINCE times long ago ships have been yearly going out from their native ports in pursuit of the whale. The vessels of the ancient Basques, and the fleets of the Hanse cities, of the Netherlands, and of

* Dr. Boas spent about twelve months, from August, 1883, till the 25th of August, 1884, in exploring from his headquarters, at the Kikkerton Islands whaling-station, the coasts of Cumberland Sound and Davis Strait. Though he was prevented by the changes of the weather, and an epidemic that raged among the dogs, from accomplishing as much as he had contemplated, he made numerous explorations in Cumberland Sound, and followed the western coast-line of Davis Strait as far as Cape Raper in latitude 69° 50′ north, traversing in all his journeys nearly 2,400 miles of country, most of which had been previously unexplored. He learned the language of the Eskimos, and acquired much interesting information respecting their customs, traditions, and religious observances, some of which are presented in this article. The sketches have been furnished us by the author in slips of the "Berliner Tageblatt," and have been translated from the German for "The Popular Science Monthly."

the Norwegians, enticed by the lucrative pursuit, eagerly pressed forward into the dangerous frozen sea. Enterprising sailors were constantly opening new hunting-grounds to the fishers, some of which are still frequented by whale-hunters. Besides the East Greenland Sea, Baffin's Bay and Davis Strait were among the best-known hunting-grounds, and were visited every year by fleets of Scottish and American whalers. In May, the ships leave their home ports and sail in the toilsome and dangerous route along the west coast of Greenland, toward the north, to reach the fishing-ground in the east and south-east of Lancaster Sound. The whales resort to this region in the latter half of July, while later, after the broad girdle of coast-ice on the west side of Davis Strait has broken up, they go farther south.

When the whales had become more rare here, in the fourth decade of the century, the brave William Penny, who afterward distinguished himself in the expeditions in search of Franklin, determined to seek for new and richer fields, and penetrated into the half-forgotten Cumberland Sound, whose waters were numerously populated by whales. As he was accustomed to have frequent dealings with the natives, friendly relations were soon established between the inhabitants of the sound and the whalers; and, although Penny desired to enjoy his new discovery all to himself, he was shortly followed by an enterprising American captain, and the rich fishing-ground he had found was no longer the secret of one man. As early as May and June, when the ice breaks up in the sound, many whales appear at the floe-edge, and were pursued by the natives in their skin-boats. But, as the entrance to the sound was closed at this season by the heavy and broad pack-ice, it was not supposed that any advantage could be taken of this fact till a shrewd captain thought of wintering over two boats' crews, so that they could begin the chase early in the spring. These crews were not very strong in numbers, and they added to their force by enlisting Eskimos, who gave their services readily for a little pay. The experiment proved profitable, and was followed by several ships, till Cumberland Sound became lively in both summer and winter. Other factors preferred to send out their ships only once a year, leaving their men to live in houses which were prepared at home and set up on the fishing-grounds. The whales were pursued without mercy, and have accordingly diminished so rapidly that the region, which had for a short time witnessed the most lively activity, has been deserted by nearly all the ships. Only a few scattering graves now remind us of the time when the stir of enterprise prevailed here.

Two stations are, however, still kept up. They continue to follow the custom, established in the beginning, of employing Eskimos and manning the whale-boats with them. It appears that the sound, at the time it was first visited by the whalers, was inhabited by about two thousand Eskimos, but they have diminished since then with really frightful rapidity, till now they hardly number three hundred

persons, who are distributed among seven settlements. The Kikkerton Eskimos, who alone once manned eighteen boats, representing a population of about four hundred and fifty heads, now number only eighty. The two fishing-stations are situated on Kikkerton, an island on the east coast of the sound. When the Eskimos who have spent the summer up the fiord return at the beginning of October, they eagerly offer their services at the station, for they receive in payment for a half-year's work a gun, harmonicum, or something of the kind, and a ration of provisions for their families, with tobacco, every week. Every Saturday the women come at the blowing of the horn into the station-house, to receive their bread, coffee, and sirup, and the precious tobacco. In return, the Eskimo is expected to deliver a piece of every seal he catches into the kitchen of the station.

The time for the fall catching commences as soon as the ice begins to form. If the generally stormy weather permits it, the boats leave the harbor to look out for the whales, which are accustomed to go along the east coast of the sound toward the north. During the last years the catch was very unprofitable, for only a few whales were seen. As the ice forms very quickly, the boats must be brought back to the land by the end of October or the beginning of November. Since whales have become scarce, the stations have followed the business of collecting seal blubber and skins, which they buy from the Eskimos.

A lively traffic springs up as soon as the ice has become strong enough to allow sledges to pass from shore to shore. The sledges of the stations are sent from one settlement to another, to exchange tobacco, matches, coffee, bread, etc., for skins and the spare blubber which the Eskimos have carefully saved up. The natives themselves, who need useful articles like cooking-pots, lamps, etc., collect quantities of hides and blubber, and come to Kikkerton to supply their wants. Eskimos come over from the southern part of the west coast of Davis Strait to exchange bears' skins for articles they want. The winter passes quickly away amid this stir of business, till everything comes to a stop in April. For now the seals cast their young, whose white, long-haired skin forms an important element in the clothing of the people. As the hunting-season only lasts a month, the natives put the time to a good use; and the old settlements are quickly deserted, for the seals are to be found most abundantly in the fiords and among the rough ice, which are the least productive places in winter.

When the sun has reached such a height that the snow begins to melt in favored spots, a new life begins at the station. The skins which had been collected in the winter, when frozen, are brought out of the store-room and exposed to the beams of the sun. A number of Eskimo women busy themselves, with their half-moon-shaped knives, in cutting the blubber from the skins and putting it away in tubs. Others clean and salt the skins, which are likewise packed away. The men also find enough work to do after the catching of the young seals

is over. The whale-boats must be got ready for the spring fishing. New Eskimos, who have been engaged by the station for the next month, come down daily, with their families and all their goods, to take up their abodes at Kikkerton. The boats are dug out from the deep snow, the oars and sails are looked after, the harpoons are cleaned up and sharpened, and everything is in busy preparation. The boats are made as comfortable as possible, with awnings and level floors, for their crews are not to come to the shore again for about six weeks.

By the beginning of May, the arrangements having been completed, the boats are put upon the sledges, and, under the direction of native drivers, are drawn by dog-teams, with their crews, to the edge of the ice. The sledges being heavily laden, and food for the dogs having to be provided by hunting, the day's stages are short. Arrived at the floe-edge, the sledges are unloaded and the boats are launched. Here is a profusion of seals and birds of all kinds, and the chase is opened without delay upon everything that is useful and can be shot. Sledges are regularly sent back to Kikkerton with skins and meats for the families of the Eskimos, while the blubber is packed in tubs which are kept ready on the spot.

The most important object of the expedition is the whale. Harpoons and lines are always in readiness for the contest with the mighty monster. The whale-fishery has been so often described that I pass over the already well-enough known details of the exciting chase. The peculiar circumstances in the sound give to the capture here a character which is exhibited in no other region. The boats go back to the north with the breaking up of the ice, and the fishing closes in July. The Eskimos are paid off and dismissed, and resume their reindeer-hunting, while the whites are glad to enjoy some rest after weeks of exhausting labor.

Unless the results of the whale-fishery improve within a short time, the period can not be far distant when the last of the whites will abandon the unprofitable land. Then the Eskimos, who can no longer live without powder and shot, will be compelled to remove from the sound and make their home on the shores of Davis' Strait, which is visited every year by ships; and Cumberland Sound may, perhaps, become more desolate than it was before its apparently inexhaustible richness in whales attracted whole fleets to its waters, and gave the region an important place in the world's trade.

When our ship, the German schooner Germania, was about to enter the port of Kikkerton in the summer of 1883, there came a boat-load of Eskimos to offer us their help. I had not formed a good opinion of the appearance of these people, but I was really astonished at the figures I saw. The little bandy-legged fellows who ran laughing and chewing over the deck of the vessel, with their long black hair, flat faces, and dripping eyes, made an extremely repulsive impression; and when we were visited by a boat-load of women, among whom were a

few antiquated matrons, my aversion toward my future fellow-residents reached its highest point. It really seemed as if the ugliest of the ugly had been selected to receive us, for I was afterward surprised by many a cheerful and pleasant face, or a strong, well-built figure. These first Eskimos appeared at least relatively neat, for they had probably held a grand feast of purification before the arrival of the ship. I had an opportunity to observe what a good influence intercourse with the whites had had upon the natives, when I came into a settlement on Davis Strait, which had never been visited by a European. I would not undertake to describe the appearance it presented, so odious was it. When I related to the Eskimos of Cumberland Sound the unhappy experiences I had suffered in the oily and filthy huts of this tribe, they answered: "We are like the cleanly gulls, which have, indeed, to look to the oil and fat of seals and walruses for their food, but still keep their feathers tidy; but they are like the Mollimoke, which wallow in blood and fat, and do not mind any kind of dirt."

The fur dresses of our Eskimos appear to be well made, and adorned with trimmings of different kinds of skins. Particular attention seemed to have been given to the reindeer-skin jackets of the women, with their long tails reaching to the ground, and to the wide hoods in which the children are carried. The short breeches reaching to the knee, of white seal-pups' skin, were very handsome. Afterward, when I became better acquainted with my new friends, I perceived what a disadvantage an indolent woman could be, even in this country, when she can not or will not keep up with her household duties. The clothes of the family too often bear witness to her neglect, and I have sometimes pitied the poor men who have to go to their seal-hunting in cold winter weather, without enough clothing. Among the first women who visited us were some unusually adorned with a cotton garment, which was occasionally exposed under their fur jackets. The men also appeared to be well clothed in seal-skin jackets, small hoods, and breeches ornamented with variously colored furs. Their long hair, loosely fluttering about their heads, gave them a wild appearance; but their quiet eyes, and the childish pleasure they exhibited on every opportunity, contradicted this. They all greatly enjoyed the much-desired tobacco, for the provision at the station had given out some time before, and they had been obliged, willing or unwilling, to practice abstinence, and not to smoke. When they had got entirely out, they had broken up their clay pipes and chewed the pieces for the sake of the taste of the little tobacco that had been absorbed in them.

A little while after casting anchor, we visited the summer tents of the natives. We had not got very close to them before their proximity became quite obvious by the strong odor of the skins of which they were made. The front part, which is made of split, semi-transparent skins, impressed itself very strongly and disagreeably on my

olfactory nerves, and when I drew the curtain and looked around on the piles of meat, the filthy cooking-vessels, and the heaps of reindeer-skins in the background, I ran out and away as quickly as I could. If any one had told me then that I would soon be living without repugnance in just such surroundings, I should have resented the insinuation very angrily. But it was not long before the stress of circumstances and custom brought me to it, and I too found myself sharing the deer-skin bed-place of the natives and cooking with them in the same kettle, though I generally took the precaution to use my own. Even the store of meat heaped up in the sides of the hut was often only too welcome to me, as was also the hospitable lamp by which the housewife sat caring that the wick should be kept well supplied with oil, and should burn evenly without smoking. With what joy, returning from a journey wet and chilled through, did I often greet the cheerful fire which warmed the hut comfortably, and the kindly hostess who dried and cleaned my clothes; and how haltingly did I as often leave the hospitable roof to go out on my solitary journeys from coast to coast, or into uninhabited regions!

The few tents which we found on our arrival at Kikkerton were inhabited by the Eskimos of the Scottish station, while all the other natives had gone fur-hunting; for as soon as the spring fishing is over and the sound is tolerably free from ice, they go in their boats up the fiords and set up their tents at the extreme ends of them.

While the women and older men stay here to catch salmon, of which immense numbers abound in the ponds and rivers at this season, the younger and more active go for days' journeys into the interior, sometimes getting as far as a hundred miles or more from their settlements. If they kill a large number of reindeer, they only bring the best meat and the skins on their backs to the camp. Then a great feast is given. All the people of the settlement are called together. An open fire of brush blazes under the kettle of meat, and every one has his part in the meal. The skins are carefully preserved, to be made up afterward into winter clothing. A favorite summer resort of the Eskimos is the great Lake Netilling, west of Cumberland Sound, the shore of which is frequented by numerous herds of that animal; and many start for that place with sledges in May.

While I was exploring the east coast of the sound with boats in the fall, a large number of Eskimos came back from their summer journeys. Some of them used old whale-boats, which they had got from some ship. The craft were loaded to the edge with the skins obtained during the season. Men, women, and children were singing, laughing, and chattering, dogs were howling, and every once in a while one person or another would reach down into the always-full pot that stood in the middle of the boat. Only the helmsman sat earnest and majestic on his high seat, and steered his craft. If the wind was unfavorable, oars were used. Occasionally a seal would lift his head out

of the water, and, if there was no particular reason for haste, they would stop, and every one would hold his gun in readiness to cover the animal if he should come up again to take breath.

All the Eskimos have returned by the middle of October, and, as it is now getting perceptibly cold, they immediately begin to build their winter houses. Several families occupy a common tent, which is now covered with brush, and over this is spread another coat of skins. The bedroom in the back of the hut and the meat- and lamp-rooms on both sides of the door are raised about two feet, so that the cold air shall not cool the living-room too much. When the lamps are burning, the room soon becomes comfortably warm, and at least a little fire is kept up day and night. Later in the winter the people begin to build their snow-houses, the size of which varies according to the number in the family. Large blocks are cut out of the wind-hardened snow, which the Eskimos skillfully build up into a high dome. The joints are carefully closed, and the whole is smoothed on the outside. The wind and the cold air are kept out of the dwelling-room by means of smaller domes and a long entrance-way. This hut, covered with skins, makes a very nice winter home.

Since the Eskimos require much blubber in the winter for their lamps, their principal hunt is for the seal. So long as the ice does not cover the whole sound, they go to its edge to shoot the seals, which are then dragged ashore with harpoons. This kind of hunting is very dangerous, for they unavoidably have to go upon the drift-ice to secure the dead seals, and this is very liable to move when the wind suddenly changes. Thus a young man, a few seasons ago, was held for three days on a cake of ice without being able to get to the shore or having anything to eat. He evidently did not lose heart, for, while his fate was still uncertain, he made a comic song about his misfortune, which is now sung by all the Eskimos in the region.

If the sea is wholly covered with ice, guns can not be used, but the hunters have to go to the breathing-holes, which the seals keep open all the winter, in order to harpoon them when they come up. The Eskimos also travel much at this season. Sledges flit from one settlement to another. Friends and relatives visit one another, and a lively trade springs up at the whalers' stations. I, too, began to travel, and, as I lived at various times in different settlements, I had opportunities to become well acquainted with the manner of life and the character of the people. At every settlement I had a host, at whose house I was accustomed to stay when I was there. A white man, moreover, is a much-esteemed guest, for he usually brings fresh provision of tobacco and bread.

In May, when the heat has become stronger, the seals are accustomed to lie upon the ice and sun themselves. Then the Eskimo brings out his gun again: he carefully approaches his victim, who is generally warily looking around; lies down upon the ice and imitates

the movements of the seal, which is taken in by the deception. When he has at last got near enough, he brings down his game with a well-aimed shot. Times are good now, for this kind of hunting yields several seals a day. Then comes the golden season of summer, bringing plenty of birds, eggs, salmon, reindeer, seals, and walruses—summer, with its gay flowers and rushing streams, freeing the seas from their icy fetters—a season which the Eskimo loves, and the beauty of which he celebrates in his songs. Thus closes the circle of the year of this people, careless and contented under the most straitened circumstances, whose hospitality and indomitable serenity I learned during my life among them to love and prize.

When, late in the fall, storms rage over the land, and again release the sea from the icy fetters by which it is as yet only slightly bound; when the loosened floes are driven one against another, and break up with loud crackings; when the cakes of ice are piled in wild disorder against or upon one another, the Eskimo believes he hears the voice of spirits which inhabit the mischief-laden air.

The spirits of the dead—the Tupilak—knock wildly at the huts which they can not enter, and woe to the unhappy person whom they can lay hold of! He immediately sickens, and is fated to a speedy death. The wicked Krikirn pursues the dogs, which die as soon as they see it with convulsions and cramps; Kallopalling appears in the water, and drags the brave hunters down, and conceals them in the great hood of his duck-skin dress. All the countless spirits of evil—the Torgnet—are aroused, striving to bring sickness and death, bad weather, and failure in hunting. The worst visitors are Sedna, mistress of the under-world, and her father, to whom dead Innuit fall.

The old stories which mothers relate during the long winter evenings to their timidly listening children tell of Sedna. Once upon a time there lived a Jnnung, with his daughter Sedna, on the solitary shore. His wife had been dead for some time, and the two led a quiet existence. Sedna grew up to be a handsome girl, and the youth came in from all around to sue for her hand, but none of them could touch her proud heart. Finally, at the breaking up of the ice in the spring, a fulmar flew from over the sea and wooed Sedna with enticing song. "Come to me," it said; "come into the land of birds, where there is never hunger, where my tent is made of the most beautiful skins. You shall rest on soft deer-skins. My fellows, the storm-birds, shall bring you all your heart may desire; their feathers shall clothe you thickly; your lamp shall always be filled with oil, your pot with meat." Sedna could not long resist such wooing, and they went together over the vast sea. When at last they reached the country of the fulmar, after a long and hard journey, Sedna discovered that her spouse had shamefully deceived her. Her new home was not built of beautiful pelts, but was covered with wretched fish-skins, full of holes that gave free entrance to wind and snow. Instead of white

reindeer-skins, her bed was made of hard walrus-hides; and she had to live on miserable fish which the birds brought her. Too soon she discovered that she had thrown her fortune away when, in her foolish pride, she had rejected the Innuit youth. In her woe she sang:

"Aya! father, if you knew how wretched I am, you would come to me, and we would hurry away in your boat over the waters. These strange birds look unkindly upon me. The cold winds roar around my bed; they give me miserable food—oh, come and take me back home! Aya!"

When a year had passed, and the sea was again stirred with warmer winds, the father left his land to visit Sedna. His daughter greeted him joyfully, and besought him to take her back home. The father, pitying his daughter, took her in his boat while the birds were out hunting, and they quickly left the country which had brought so much sorrow to Sedna. When the fulmar came home in the evening, and found his wife not there, he was very angry. He called his fellows around him, and they all flew away in search of the fugitives. They soon discerned them, and stirred up a great storm. The sea rose in immense waves, that threatened the pair with destruction. In his mortal peril the father determined to offer Sedna up to the birds, and threw her overboard. She clung with a death-hold to the edge of the boat. The cruel father then took a knife and cut off the first joints of her fingers. Falling into the sea, they were changed into seals. Sedna, holding to the boat more tightly, the second finger-joints fell under the sharp knife, and swam around as ground-seals; when the father cut off the stumps of the fingers, they became whales.

In the mean time the storm subsided, for the storm-birds thought Sedna was drowned. The father then allowed her to come into the boat again. But she from that time cherished a deadly hatred against him, and swore bitter revenge. After they got ashore, she called up two dogs, and let them eat the feet and hands of her father while he was asleep. Upon this he cursed himself, his daughter, and the dogs which had maimed him, when the earth opened and swallowed hut, father, daughter, and dogs. They have since lived in the land of Adliwun, of which Sedna is the mistress.

The seals, ground-seals, and whales, which grew from Sedna's fingers, increased rapidly, and soon filled all the waters, affording choice food to the Innuit. But Sedna has always hated those people, whom she despised when on the earth, because they hunt and kill the creatures which have arisen from her flesh and blood. Her father, who has to get along by creeping, appears to the dying; and the wizards often see his crippled hand seizing and taking away the dead. The dead have to stay a year in Sedna's dismal abode. The two great dogs lie on the threshold, and only move aside to let the dead come in. It is dark and cold inside. No bed of reindeer-skins invites to rest; but the new-comer has to lie on hard walrus-hides.

Only those who have been good and brave on the earth escape Sedna, and lead happy lives in the upper-land of Kudliwun. This land is full of reindeer ; it is never cold there, and snow and ice never visit it. Those, also, who have died a violent death may go into the fields of the blessed. But whoever has been with Sedna must always stay in the land of Adliwun, and hunt whales and walruses. With all the other evil spirits, Sedna now lingers in the fall among the Innuit. But, while the others fill the air and the water, she rises from under the ground.

It is then a busy season for the wizards. In every hut we may hear singing and praying, and conjuring of the spirits is going on in every house. The lamps burn low. The wizard sits in a mystic gloom in the back part of the hut. He has thrown off his outer coat and drawn the hood of his inner garment over his head. Muttering undistinguishable words, he throws his arms feverishly around his body. He utters sounds which it is hard to ascribe to a human voice. At last the guardian spirit responds to the invocation. The *Angeko* lies in a trance, and when he comes to himself he promises, in incoherent phrases, the help of the good spirit against the Tupilak, and informs the credulous, affrighted Innuit how they can escape the dreaded evil.

The hardest task, that of driving away Sedna, is reserved for the most powerful wizards. A rope is coiled on the floor of a large hut, in such a manner as to leave a small opening at the top, which represents the breathing-hole of a seal. Two wizards stand by the side of it, one of them holding the seal-spear in his hand as if he were watching at the seal-hole in the winter, the other holding the harpoon-rope. Another Angeko sits in the back of the hut, whose office it is to lure Sedna up with magic song. At last Sedna comes up through the hard earth, and the Angeko hears her heavy breathing ; now she emerges from the ground, and meets the wizards waiting at the hole. She is harpooned, and sinks away in angry haste, drawing after her the harpoon, to which the two men hold with all their strength. Only by a desperate effort does she tear herself away from it and return to her dwelling in Adliwun. Nothing is left with the two men but the blood-sprinkled harpoon, which they proudly show to the Innuit.

Sedna and the other evil spirits are at last driven away, and a great festival for young and old is celebrated on the next day in honor of the event. But they must still be careful, for the wounded Sedna is greatly enraged, and will seize any one whom she can find out of his hut. So, on this day, they all wear protecting amulets on the tops of their hoods.

The men assemble early in the morning in the middle of the settlements. As soon as they have all got together, they run screaming and jumping around the houses, following the course of the sun. A few, dressed in women's jackets, run in the opposite direction. They are those who were born in abnormal positions. The circuit made, they

visit every hut, where the woman of the house must be waiting for them. When she hears the noise of the band, she comes out and throws a dish of little gifts of meat, ivory trinkets, and articles of seal-skin into the yelling crowd, of which each one helps himself to what he can get. No hut is spared in this round.

The gang next divides itself into two parties, the Ptarmigans—those who were born in the winter—and the Ducks, or the children of summer. A large rope of seal-skin is stretched out; each party takes one end of it, and tries with all its might to drag the opposite party over to its side. But they hold fast to the rope, and try as hard to make ground for themselves. If the Ptarmigans give way, then summer has won the game, and fine weather may be expected to prevail through the winter.

The contest of the seasons having been decided, the women bring out a large kettle of water, and each person gets his drinking-cup. The company stand close around the kettle, while the oldest man steps out first from among them. He dips a cup of water from the vessel, sprinkles a few drops on the ground, turns his face toward the home of his youth, and says, "My name is Naktukerling, and I was born in Kajossuit." He is followed by an aged woman, who announces her name and home; and then all the others do the same, down to the youngest children, who are represented by their mothers. As the words of the old are listened to respectfully, those of distinguished hunters are received with demonstrative applause, and those of the others with different kinds of attention, down to familiar rallying.

Now arises a cry as of surprise, and all eyes are turned toward a hut out of which stalk two gigantic figures. They wear heavy boots, their legs are swelled out to a wonderful thickness by several pairs of breeches, their shoulders are covered by a woman's over-jacket, and their faces by tattooed masks of seal-skin. In their right hands they carry the seal-spear, on their backs an inflated buoy of seal-skin, and in their left hands the *tessirkun*, the tool with which the skins are prepared. Silently, and with long strides, the *Kailertetang* approach the assembly, who, screaming, press back from before them. The pair solemnly lead the men to a suitable spot, and set them in a row, against which they set the women in an opposite row. They match the men and women in pairs, and these pairs run, pursued by the Kailertetang to the hut of the woman, when they are for the following day man and wife. Having performed this duty, the Kailertetang speed down to the shore, and invoke the good north wind, which brings fair weather, while they warn off the unfavorable south wind.

As soon as the incantation is over, all the men attack the Kailertetang with a great noise. They act as if they had weapons in their hands, and would kill both the spirits. One pretends to probe them with a spear, another to stab them with a knife; one to cut off their arms and legs, another to beat them unmercifully on the head. The

buoy which they carry on their backs is ripped open and collapses, and soon they both lie as if dead beside their broken weapons. The Eskimos leave them to get their drinking-cups, and the Kailertetang awake to new life. Each one fills his seal-skin with water, passes a cup to them, and inquires about the future, about the fortunes of the hunt, and the events of life. The Kailertetang answer in murmurs, which the questioner must interpret for himself.

Thus ends this day, in which laughing and singing, joy and gladness prevail. On the morrow the Eskimo goes back to his daily life, but the autumn festival is the subject of talk in the hut and on the hunt for weeks afterward.

THE RELIGIOUS VALUE OF THE UNKNOWABLE.*

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WE have not to take part here for or against the philosophy of Evolution. The only points we wish to examine in the controversy are, first, if the historical development of the religious sentiment can be summed up into a gradual reduction of the divine attributes, into a simplification, or, to borrow Mr. Spencer's barbarous term, a deanthropomorphization of the divinity; next, if the theory of the Unknowable has all the elements necessary to beget a religion; and, lastly, if the religious sentiment is tending to divest itself of every moral element, or whether it is destined, as the Comtists maintain, to confound itself with altruism or devotion to humanity.

Mr. Harrison sharply criticises the theory that ascribes the origin of religion to *doubles* appearing in dreams. We are not fanatics in regard to this hypothesis, but would prefer to admit, with M. A. Réville, that religion began with the worship of natural objects or cosmic phenomena personified, animated, *anthropomorphized* by the imagination of the primitive man. But these reserves involve no impeachment of Mr. Spencer's general reasoning, so far as concerns either the spiritual nature of the first notion that man formed of the divine, or the work of simplification and purification which that notion has constantly undergone in the course of ages. The thesis of Mr. Harrison, on the contrary—that man began with the adoration of natural objects frankly regarded as such—appears to us absolutely contrary to reason and observation. He cites, for example, the ancient religion of China, which was based entirely on veneration of the earth, the sky, and ancestors, considered objectively and not as the residence of immaterial

* From "The Nature and Reality of Religion," being the last part of the author's review of the controversy between Mr. Spencer and Mr. Harrison, in which he presents his own conclusions.

beings. This is to play at hazard, for, without insisting on what ancestors "considered objectively" may be, it has been found precisely that the religion of the ancient Chinese Empire is the most perfect type of organized animism, and that it regarded even the material objects out of which it made its gods as the inseparable manifestation, the envelope, or even the body of invisible spirits.*

How shall we explain it that after the works of Tylor, Spencer, Max Müller, Réville, and Tiele, a thinker as intelligent and well-informed as Mr. Harrison can still pause at a thesis long ago passed by by science? It is, we believe, a remarkable instance of the influence which Auguste Comte still exerts over his orthodox disciples, and which can only be compared with that of Aristotle over the scholastics of the middle ages. We know that Comte borrowed from President De Brosses the hypothesis of primitive fetichism, and that he introduced it in the series of three states (fetichism, polytheism, and monotheism), through which religion in his view had invariably to pass.

We think, then, that Mr. Spencer is right in representing the evolution of the idea of God as tending to render the object of worship less and less sensible to man, more and more incapable of falling under our senses. But this process of abstraction must stop somewhere, else even the existence of God will at length become its victim, and that would evidently go beyond the Spencerian doctrine. The whole problem consists, then, in knowing where this stopping-place is to be found; and, according as we start from spiritual theism, from pantheism or from agnosticism, we shall be able to reach a different solution without really departing from the line of religious development.

Mr. Spencer, on his side, estimates that the end will be reached when the idea of God has been divested of all limitation and of every condition. There will then remain for us the one absolute certainty, that man "is ever in the presence of an Infinite and Eternal Energy, from which all things proceed."

Is there nothing here but a pure negation, as Mr. Harrison asserts? The terms of the formula themselves prove that the question is of what may be supposed to be the most positive thing in the world—the stuff of which the Universe is made. Mr. Spencer speaks repeatedly of the Unknowable as the power that manifests itself at the same time in the Universe and in the Consciousness, as the Supreme Reality which is concealed behind the changing course of phenomena. He attributes to it, as Mr. Harrison recognizes, unity, homogeneity, immanence, unlimited persistence in time and space. He assigns it, for modes of action, the laws of the Universe; he sets it face to face with phenomena, both internal and external, in the relation of substance to manifestation, if not of cause to effect. Still more, the Comtist critic

* See, notably, Tiele, "Manuel de l'Histoire des Religions," translated by M. Maurice Vernes, Book II; and in the "Revue de l'Histoire des Religions," the "Religion de l'Ancien Empire Chinois," by M. Julius Happel (Vol. IV, No. 6).

himself admits that we may accept with full confidence all that the evolutionist philosophy affirms and contests with reference to the permanent indications of an ultimate energy. Now, is not this concession of Mr. Harrison's the complete refutation of his thesis relative to the negative nature of the Unknowable?

He adds, indeed, that an existence of which we can know nothing remains, in the religious point of view, as if it did not exist. To this objection it may be replied that he consents himself to admit mystery as an element of the religious sentiment. We will only add to this, with Mr. Spencer, that it is an essential element of it, and in this respect the Unknowable is susceptible of satisfying the most difficult imaginations, for it is the mystery of mysteries, and something that we may be sure will never be cleared up in this world, whatever may be the progress of science. Mr. Harrison commits an error—especially strange with a positivist—when he reproaches evolutionism for using the term Unknowable instead of Unknown. The Unknown includes a knowable part, the sum of the phenomena and laws which still escape our perception, but which we may be able to know and doubtless will know more and more. The Unknowable, on the other hand, represents what will always escape our knowledge by virtue of our intellectual organization itself—the first cause, the Noumenon, the essence of things—unless Mr. Harrison, urging the doctrine of positivism to an extreme, prohibits us from mentioning all that transcends phenomena and their relations, even in order to declare it Unknowable! As M. Littré admits: "Immensity, material as well as intellectual, appears under its double character of reality and inaccessibility. It is an ocean that beats against our shore, and for which we have neither bark nor sail, but the clear vision of which is as salutary as formidable!"

A second element, which every one agrees in declaring characteristic of religion, is that feeling, of a complex nature, which is interpreted, according to circumstances, into wonder or fear, enthusiasm or stupor, before the object of religious contemplation. Is not this one of the impressions most easily engendered by the discovery of that mysterious energy that rises, at the end of all our investigations, in all the avenues of knowledge, as if by the conception of that substantial stratum which remains when all else changes and passes away—primordial foundation of Nature and consciousness, without which, if we could only suppose it absent for a second, the whole Universe would resolve itself into chaos or into nothing?

Schleiermacher referred the essence of religion to a feeling of dependence. Does not Evolution teach that the force of which we are conscious whenever we produce a change by our own effort is correlative to the power that transcends consciousness, and can we imagine a closer dependence than this relation of the individual with the ultimate Energy of which it is, like all of Nature, a transient production?

It is of a power conceived in this manner that we may well say, *In illo vivimus, movemur, et sumus* (in it we live, and move, and are).

The conditions indispensable to becoming the object of a religion are thus found in the Unknowable, as well as in the Eternal, the Absolute, the Self-Existent, the Most High, the Only Pure, or whatever other qualifications men may have made the equivalent of the divine. The last word of Evolution agrees with the definitions of the most refined theologists, which, transcending vulgar symbolism, have constantly recognized God in the double character of reality and incomprehensibility. We may add that, before becoming the scientific faith of Spencer, Huxley, and even of Haeckel, this religious conception has sufficed for men of the highest mind and the most pious imagination, such as Giordano Bruno, Spinoza, Kant, Goethe, Shelley, Wordsworth, Carlyle, Emerson, and even M. Rénan. It can lead not to religion only, but even to mysticism, however little, like some Neoplatonists and certain Hindoo philosophers, one may become absorbed in the conception of the supreme unity.* Under this relation, the danger is not that it will remain without influence, but that it will communicate to its adepts a kind of vertigo more formidable than the fascination of the abyss, either by the contrast of its incommensurable grandeur with the insignificance of our being, or by the opposition of its immutable Unity with the unlimited Variety and perpetual expansion of the material Universe. These sentiments, as Mr. Spencer remarks, can only increase in frequency as well as in intensity as the human mind becomes more capable in seizing the comprehensiveness of things and their complex relations.

Certainly, it is no longer possible to attribute to that Supreme Reality goodness, consciousness, and personality, *as we conceive them*. But do our conceptions exhaust the modes of the infinite? Mr. Harrison will see only the negative side of the Unknowable. Whether you employ, he tells us, the term existence or energy, you never have anything but a scientific generalization, a dumb, blind, insensible entity, without common attributes, and consequently without possible

* We cite, for example, the following passage from an address made by the great mystic of the Bramo Somaj, Keshub Chunder Sen, at a time when no one accused him of having transgressed the most strict rationalism: "(For the true Yogui) forms become informal, the informal takes form. Mind discovers itself in matter, matter transforms itself into mind. In the glorious sun is revealed the glory of glories. In the serene moon mind imbibes of all serenities. In the reverberation of the thunder is the Voice of the Lord which makes itself heard afar. All things are full of Him. Open your eyes, behold he is without; shut them, he is found within. Then your asceticism (*yoga*), O disciple, will be complete; aspire constantly to this plenitude." There is not a word in these exalted conceptions in contradiction with the religious conceptions of Mr. Spencer. Haeckel himself has said in his "Morphology": "The philosophy which sees the mind and force of God acting in all the phenomena of Nature is alone worthy of the grandeur of the Being who embraces all. . . . In him we live, and act, and are. The philosophy of nature becomes theology." All depends on the mental angle under which the disciple of Spencer contemplates Nature, or the manifestations of the Unknowable.

sympathy with man. Mr. Spencer meets the objection in advance in his "First Principles." "Those who espouse this alternative position," he says, "make the erroneous assumption that the choice is between personality and something lower than personality; whereas the choice is rather between personality and something higher. Is it not just possible there is a mode of being as much transcending Intelligence and Will as these transcend mechanical motion? It is true that we are totally unable to conceive any such higher mode of being. But this is not a reason for questioning its existence; it is rather the reverse. Have we not seen how utterly incompetent our minds are to form even an approach to a conception of that which underlies all phenomena? Is it not proved that this incompetency is the incompetency of the Conditioned to grasp the Unconditioned? Does it not follow that the Ultimate Cause can not in any respect be conceived by us because it is in every respect greater than can be conceived?"

Energy is a word that has a bad sound to many ears. We apprehend in it the idea of brute, of material force. Here, again, Mr. Spencer is able to tell us that we let ourselves be carried away by the analogy of muscular effort. But all the languages of civilized peoples permit us to rise above this literal acceptation, and to interpret the term in a larger sense, as implying mental and moral activities. If the Universe, with its laws and harmonies, if man with his capacities and aspirations, proceed from the same Energy, it must be that that Energy contains in puissance whatever in our eyes goes to constitute the grandeur of Nature and the glory of the human mind. Further, as it should likewise include the germ of all its future, or even possible developments, it must necessarily represent a cause superior to all its known effects—that is, to the finest and highest manifestations of that which we regard as the rational order of things.

Mr. Harrison finally declares that the Unknowable can never have temples, rites, or ministers. We will not inquire here to what point these are indispensable elements of religion. The ascetic school of India, a fruit of the reaction against the excessive ritualism of the Brahmans, has always dispensed with external worship. We can easily conceive the religions of Mohammed and Confucius as without mosques or pagodas. Buddhism probably had convents long before it built temples. At Rome itself, seventeen centuries ago, there flourished a sect already numerous, whose partisans and adversaries agreed in saying that it had neither temples nor altars nor images.* So it was regarded as atheistical. It must be acknowledged that the sect has acquitted itself well since then. In any case, the affirmation of the Comtist writer is already contradicted by the facts. Not only have we Protestant theologians, more or less orthodox, who are endeavoring to reconcile the doctrine of evolution with faith in the Christian revelation, but we can point to liberal and even Unitarian congregations

* Minutius Felix, Octav, pp. 10, 32.

in America and England, whose whole theology consists in Mr. Spencer's religious conception, and who do not hesitate to avow the fact. If Mr. Harrison will take the pains to visit them, he will see that, even after all the old theological formulas have been given up, the Unknowable can serve as the foundation of a worship, without being reduced to the formula and symbol of x^n.

But these disciples of Spencer, by developing the religious consequences of his doctrine, have made up for his silence on perhaps the only point in which he exposes his flank to the attacks of Comtism. Feeling that the flaw in the armor is revealed here, Mr. Harrison keeps on reiterating the charge, and reproaching his adversary with having forgotten that religion necessarily includes a moral discipline. We believe it is inexact to assume that morals is an original element of religion, but it incontestably, by the progress of ideas, has become an essential one. In reducing religion to a sort of mystic contemplation, Mr. Spencer has left out those moral sentiments and practical applications which, according to the just remark of Mr. Harrison, are the real sphere of religious activity. Evolution confides to science the task of formulating the laws of ethics, or, in more general terms, the principles of the true, the good, and the beautiful. But does Science, which addresses itself exclusively to the reason, possess a sufficient sanction to guarantee, under all circumstances, the triumph of those laws over the appetites or the passions of the individual, when once the commandment of a divine revelator or the categorical imperative of Kantian morals has been replaced by the simple suggestions of plain interest? It is, we believe, in sentiment, as Comte and his disciples declare, that must be sought the mainsprings of duty, of devotion, of the spirit of sacrifice, and of all the virtues which, perhaps, yet more than mental progress, make up the grandeur of the individual and the strength of societies.

What is this sentiment, which, to attain its end completely, must represent our deepest and most intense aspirations? Worship of Humanity, replies Mr. Harrison, following Comte. But humanity can not isolate itself from Nature, and Nature itself is simply the phenomenal manifestation of the Supreme Energy. Mr. Spencer has already said, in his first studies of sociology, that nothing like humanity can remove, save temporarily, the idea of a power of which humanity is the feeble and fugitive product, a power which, under ever-changing manifestations, existed long before humanity, and which will continue to manifest itself under other forms when humanity shall be no more.

It remains to examine whether the contemplation of this power can provoke in us sentiments that will practically affect our conduct. The response can only be affirmative, provided we consent, with Mr. Spencer, to regard the laws which reason discovers in the moral as well as in the physical world as modes of the Unknowable. Comte has defined religion as the state of spiritual unity resulting from the conver-

gence of all our thoughts and all our acts toward the service of humanity. How much stronger and more efficacious would this state of spiritual unity become if, instead of resting exclusively on the necessary relations of men, it based itself on the sum of our relations with the Universe, and if, while retaining as its object the reign of justice or happiness in human society, it enveloped that object in the broader end of the conformity of our conduct with the action of the power "other than ourselves, which labors to put order into the world," or, as Matthew Arnold defines it in his felicitous and celebrated formula, "the Power not ourselves, that makes for righteousness"!

But is not this to attribute to the Unknowable an object, a design, a will—attributes absolutely incompatible with the unconditioned and the infinite? Is it not, in short, to return to the doctrine of final causes which has been proscribed by Evolution?

We may answer that, if modern science has cast discredit on the old system of final causes, it has not, it appears, prohibited us from assigning a certain end to the evolution of the Universe taken as a whole; that the tendency toward this end, aside from knowing whether it is conscious or not, intelligent or not, is easily substantiated by the numberless indications of a gradual progress in the development of nature as well as of humanity; and that this tendency toward a determined end contradicts the system of evolution only in so far as it may be copied after the manifestations of our volitional activity. If a person holds that the notions of object, end, tendency, and predetermination are derived from our subjective experiences, we should observe—as Mr. Spencer has done of our notion of force, deduced from the muscular effort—that we are constrained to think of external energy in terms borrowed from our consciousness of internal energy, and that there is nothing to prevent our seeing equally in the notions thus formed the simple symbol of the reality. The essential point is not to forget that here also the Unknowable should be superior and not inferior to our broadest conception of the human faculties.

We have, however, no need at this time to go beyond Mr. Spencer's written thought. He affirms that the laws of Nature are the modes of action of the Unknowable, and that the most important of them, the law of evolution, tends, in the existing Universe, to equilibrium, harmony, and co-ordination, which is interpreted in the moral world by a more complete submission to the injunctions of duty, by the introduction of more justice into the relations of men; in short, by the gradual realization of the conditions necessary to the constant progress of the individual and of society. The more, then, man is conscious of his relations with the Unknowable, and the more he comprehends the solidarity that binds all parts of the Universe, chiefly the members of humanity, the more he will grasp the importance of his modest part in the great drama of Evolution, and the more he will

feel inclined to follow the elevated aspirations of his nature, regarded as the expressions of the Eternal Energy, which, if the philosophy of Mr. Spencer is not a vain illusion, is leading us toward a better future.

Thus the religion of the Unknowable assimilates to itself an ultimate factor which is found in all religions ; the desire of uniting one's self with the object of worship, or, at least, of conforming to the rules that proceed from it. Mr. Spencer seems himself to have comprehended the necessity of this extension, if we may judge from a letter which he addressed last year to one of his most earnest disciples in the United States, the Rev. J. M. Savage, a Unitarian minister, in which he felicitated him on having clearly brought out the religious and ethical sides of evolutionary doctrines.

On the other hand, the resources which the religious spirit discovers in the doctrine of the Unknowable have struck even some of Mr. Harrison's co-religionists, who, less bound, perhaps, to the letter of Positivist tradition, have recognized the necessity of giving a broader and more solid support to the worship of Humanity. As Mr. William Frey, an American Comtist, wrote to the Boston "Index" in 1882, the strong feeling which the Comtists experience toward humanity can only become deeper and more intense if they regard it as a mediator between men and the Unknowable, because there will come into play the strongest cord of the religious sentiment—the aspiration of man toward the Infinite.

We should not be surprised at the influence, amounting to a kind of fascination, which the philosophy of Mr. Spencer exercises over an increasing portion of the Anglo-Saxon public. Whether true or false, complete or incomplete, it unquestionably represents the vastest and grandest synthesis that human genius has produced for a long time. After having embraced in succession all the phases of cosmical evolution, all the degrees of organic, sensible, intellectual, and social development, we could foresee that the eminent thinker would enter the domain of religious ideas to inquire into the application of his general law there. We have seen by what conclusions, at once sympathetic and original, his views, in this regard, trench upon nearly all the systems that have issued from the contemporaneous scientific movement.

In 1860 Mr. Laugel called him the last of the English metaphysicians. Mr. Spencer would no more accept this designation now than then. It is nevertheless true that his doctrine of the Unknowable, as Mr. Harrison asserts, is, before everything, of theology, and that in his hands the evolution of Religion becomes the religion of Evolution. The future alone can tell what lot is reserved for this conception, which is doubtlessly not new in itself, but which, for the first time, perhaps, is presented to us as the logical and indispensable complement of a system exclusively based on Positivist methods.

LIQUOR LEGISLATION.

By GORHAM D. WILLIAMS.

DURING the past eight years as a magistrate with criminal jurisdiction in a town of about four thousand inhabitants, in Western Massachusetts, I have disposed of about five hundred cases of drunkenness, and numerous cases of common drunkards, brought before me on complaint. The proceedings have not been mere routine, as, of necessity, they usually are in such cases in the large cities, where the judge sits back in his chair until the list of the morning's "drunks" has been finished by the clerk, who calls name after name, with the formula, "John Smith, you are complained of for being drunk yesterday. What do you say to this complaint, are you guilty or not guilty? You are sentenced to pay a fine of one dollar and costs, and to stand committed to the House of Industry for ten days, or till the same is paid"; and who begins to write the memorandum of the sentence as soon as he calls the name, and scarcely pauses for the plea of guilty. In the cases coming before me I usually have from the officer making the arrest some description of the circumstances under which it has been made, while in the cases of common drunkards I usually know something of the history of the defendant. In cases of simple drunkenness, the law being the same, I usually end with a sentence like that given above, though occasionally I adjourn a case for sentence, and give the defendant a chance to raise or earn the money, and pay the fine on a subsequent day. The case of a common drunkard is not so easy to dispose of, for, in the first place, he is liable to a severer punishment, then he is usually a resident of the town, I know all about him and his family, if he has one, and there is a sort of an acquaintance between us on account of his having been before me on numerous occasions for simple drunkenness. Moreover, he has just been on a spree, and is in a condition of reaction, confident that he will never desire to drink intoxicating liquor again, and full of good resolutions. All this leads to an appeal for a chance to show that he is a reformed man, to promises that he will never give occasion to be arrested again, and to offers to take the pledge, and usually ends with the sentence being postponed for a week or two—then for a month, and then indefinitely, after which he is arrested a number of times for drunkenness, and, the patience of officers and magistrate becoming worn out, the complaint for being a common drunkard is revived, he is sentenced and appeals, counsel is employed, and his case drags along in the superior court.

The law as to drunkenness and common drunkards, as it now stands, can not be administered with any satisfaction. The imposition of a fine in such cases is a punishment whose burden, if the fine is paid, is

borne by the family of the drunkard, whose condition, already wretched enough on account of the vice to which he is addicted, is thus made still more deplorable. Imprisonment for a first offense is not permitted, and in any case seems a punishment disproportioned to an offense in the commission of which the defendant has done himself more harm than he has the public; and this is especially true when the arrest has been made, as frequently happens in the winter, out of pure compassion, to save the defendant from injurious exposure to the cold. Besides, short sentence to imprisonment can be no satisfactory offset to the expense already incurred in the arrest, for, as a prisoner on short sentence, the convict becomes the occasion of an additional item of expenditure. To discharge him without sentence is the only other course open, and this it is useless to discuss if it is to be admitted that an arrest should be made at all.

The experience gained from the cases mentioned, although they have not been exceedingly numerous, has yet been sufficient to teach me some facts, and to occasion a good deal of thought on the matter of temperance legislation. I have noticed that the number of arrests for drunkenness has not varied with the number of places open for the sale of intoxicants. In fact, in one year, when no licenses for their sale were granted in our town, the arrests were unusually numerous, and this was due to the fact that there were a large number of imported laborers employed in certain railroad-work in the neighborhood, and that from among them the "drunks" were furnished. From this it would seem that the habits of the community have more to do with the consumption of intoxicants than the number of places of sale. The nationality of the persons arrested looks in the same direction The simple "drunks" have been for the most part Irish; the common drunkards, American, who have been almost exclusively permanent residents, perfectly well known to the overseers of the poor, the peace officers, and the magistrates. I can not recall that a German has ever been before me for either offense, and this although there is a large German population in the village where I reside. From all the foregoing I come to the conclusion that the present license law in Massachusetts does not, and that the prohibitory law when in existence did not, affect the drinking habits of more than a very small portion of the community. The question is, What legislation is necessary or desirable under these circumstances?

The unusual characteristics of the presidential election of 1884 have thrown into peculiar prominence a movement to make prohibition of the traffic in intoxicating liquors a national issue. The object of this movement is to get incorporated into the fundamental law of the Federal Union, by way of constitutional amendment, a provision for such prohibition or requiring such prohibition by the States. To one who has made even a superficial study of the Constitution of the United States this must seem a wide departure from the spirit in which that instru-

ment was framed. It proceeds upon the claim that any use of intoxicating liquors as a beverage is injurious to the user, a claim not yet proved, and certainly not yet by any means admitted, and that whatever is injurious to an individual, if it in any way affects the public injuriously, may be prevented, not by direct punishment of the offender, but indirectly by a sweeping prohibition forbidding all persons to furnish the means of committing the offense. If such law-making can be defended at all, it can be only as the making of police regulations, for which the frame of government of a federation of States seems a very curious place. Amendments or provisions of the Constitutions of the several States are equally objectionable on considerations of sound legislation. The great mistake made by temperance agitators who favor prohibition is that they expect too much from the mere passage of laws. They know that in our highly civilized, orderly, and law-abiding communities there are laws for the punishment of all the grave offenses, such as murder, arson, burglary, and the like, and against almost innumerable misdemeanors and petty offenses; they see that offenses against such laws are not of frequent occurrence, and by hasty generalization, and usually without experience in the workings of the law, they draw the conclusion that the passage of a law making a certain act an offense and forbidding it has a potent effect in preventing it. In spite, however, of all the experiments that have been tried in legislating on the sale of intoxicating liquors, and varied and numerous statutes on the subject, the evil aimed at still exists. Hasty reasoning from this state of facts leads to the conclusion that it is not the law that is in fault, but the method of its enactment. Our prohibitionist friends know that there are no departures to a noticeable extent from the provisions of the Constitution of the United States and of the several States, and conclude that if they can get the enactment they desire into the Constitution it will have an effect that it can not have while only existing in the form of a statute. The real reason that there are violations of statutes and not of the provisions of Constitutions is that statutes and Constitutions deal with, and are intended to deal with, different kinds of law. The Constitution in general terms provides the frame of government for the State, distributes the legislative, judicial, and executive functions, and sets forth the powers of the Legislature, the courts, the Governor, and his associates; while statutes are enacted to fill in the details not covered by the Constitution, to erect and prescribe the powers of municipal, religious, charitable and other corporations, to regulate the relations of individuals to one another, the making of contracts, the settlement of estates, and the like, and to provide for the punishment of offenses against the community. A statute has the same force and effect while it exists that a provision of the Constitution has. It is easy to be understood that a constitutional provision for the punishment of murder would not be in the least more likely to prevent the commission of

that crime than a statute to the same effect. How, then, can it be expected that the recent adoption of a constitutional amendment in Maine is going to have any effect in the prevention of the sale of intoxicating liquors? Such sale has been forbidden in that State for more than thirty years. Prohibition has been the law of the State for all that time just as much as it will be now, and, if it has failed in the past to produce the result intended, so will it in the future.

I have said that offenses agains tthe law are not of frequent occurrence, and of course that is to say in comparison with the ordinary events of life. Not one man in a hundred, probably, has even violated the provisions of the law as to the sale of intoxicating liquor. But violations of the law are more frequent in some communities than in others. The same law against murder prevails throughout the city of New York, for instance, but in certain parts of that city murder is of common occurrence when compared with other parts. The law forbids murder in all the Southern States, yet certain kinds of murder, by comparison with the Northern States, are of frequent occurrence there and go unpunished; and this is true to such an extent as to be an occasion of reproach to the condition of public sentiment there. Dueling was forbidden and punishable for many years before public sentiment was such as to permit the enforcement of the law. Now the statutes against dueling have become of little consequence, because public opinion about dueling is a sufficient law. Laws do not make people virtuous, honest, or temperate, by their mere passage. When laws punishing crime, fraud, and intemperance are enforced, they do have an influence in their prevention. But for the enforcement of the law we need not only persons ready to set prosecutions on foot and officers ready to serve warrants of arrest, but we need also courts and juries ready to convict on sufficient evidence, and witnesses willing to testify. For all these we must have an overwhelming public sentiment in favor of the law, and this is true not only of large communities like States and counties, but of small communities like villages and hamlets. Neither murder nor any other crime can be punished if those who have knowledge of the facts connected with it will not tell what they know. This is especially true of any class of crimes in which all the participants are held equally guilty; in illustration of which is the notorious difficulty of obtaining convictions for offenses against the laws as to the relations of the sexes. It is also true of offenses against the laws now under consideration, not because both parties to a sale of intoxicating liquor are held equally guilty, but because both are participants in the act which constitutes the offense, and all manly feeling, of which even drunkards have a little, revolts at testifying in such a case.

But even with public sentiment in favor of the enforcement of prohibitory laws, they have no such influence as persuasion and education. Another mistake made by temperance agitators, and one which follows

from that previously mentioned, is that they do not pursue methods calculated to bring them in contact with the persons whom they seek to benefit. If there were no liquor-buyers, there could be no liquor-sellers. So long as there are persons disposed to be liquor-buyers, there will be liquor-sellers, in spite of all the statutes and constitutional provisions that ever have been or ever can be enacted. The liquor crusade (I intend to use the word in no offensive sense) is now directed toward the overthrow of the liquor-seller, and not to the rescue of the liquor-buyer. I could greatly regard and admire the temperance missionary who should seek out the drunkard at his home or in the grog-shop, and endeavor to persuade him of the evil of his ways, of his power to reform, and of his capacity to become a respectable, respected, and useful member of society, and who makes the attempt to find such objects of interest for him as will make his home or some lounging-place as attractive to him as the grog-shop. Such missionaries are scarce, however. The usual temperance work consists in occasionally getting up meetings which respectable people, not drunkards, are solicited to attend, and at which some one holds forth on the evils of intemperance (which all are ready to admit), and dwells on the necessity for further legislation or a constitutional amendment. Not a suggestion is made that it is desirable to organize committees to solicit funds to pay for the time and services of such a missionary as aforesaid, or committees to aid him in such work. If by any chance the meeting is not devoted to a consideration of the law, and an effort has been made, or is made, to get hold of the drunkards and reform them, they are more than as likely as not to be put forward at once on their profession of reform, to tell how drunk they used to get, and to abuse persons who do not join the movement, do not believe in prohibition, and have never been drunk. Temperance work comes, too, in waves like our "cold snaps," and, after a season of intense excitement, dies away, leaving to be sure a residuum of good, but also furnishing a majority of backsliders among the reformed, to the regret of the judicious and the delight of the scoffers. What is needed is not more but different law, and sustained and unobtrusive, not spasmodic and demonstrative effort for the reform and rehabilitation of drunkards. When the history of temperance reform for the last fifty years is considered, the progress made seems astounding; but it must be remembered that the greater advance by far was made before and not since the enactment of prohibitory laws, and by persuasion, not by force.

Before going further I wish to say that I yield to no one in my appreciation of the fact that crime, wretchedness, poverty, and squalor, inevitably follow the excessive use of intoxicating drink, and that any use of intoxicants is dangerous on account of the liability that it may become excessive. I am also fully of the opinion that any law can be justified that will prevent such use of them, and, if I had the power, I would destroy every drop of alcoholic drink on the face of the earth.

But I am not prepared to admit that all the intoxicating liquor used as a beverage, or even the greater part, becomes by such use injurious to the public, so as to give it a right to interfere by prohibiting its sale, so long as any other method can be found to relieve the public from the burdens which we undertake under our system of caring for our fellows when they are unable to take care of themselves.

I am not aware that any one has ever claimed for the public a right to prohibit an individual from doing anything that does not interfere with the rights of others. If the public has no such right, it is hard to see how drunkenness becomes punishable by law unless the drunken person offensively exhibits his drunkenness. I am not aware that any one has ever claimed that the act of drinking a glass of wine or of lager-beer is morally wrong, nor that any one has ever proposed to forbid it by law. If, as is said, the use of alcoholic tonics to a certain extent is beneficial to certain persons, then there is certainly not only nothing wrong in such use, but the contrary is true. And again, if there is nothing in the use of alcoholic drinks which the public has a right to forbid, it is hard to see how it acquires a right to interfere with their sale on moral grounds alone. In a recent article in the "North American Review" Neal Dow quotes with approval certain things said by a friend of his in a conversation had with James Stuart Mill, in which his friend admits that the public have no right to interfere with what a man may eat or drink, and then claims that it has a right to do indirectly what it has no right to do directly, and gives illustrations of restrictions similar to those imposed on the traffic in intoxicating liquor. These illustrations are taken up by Dio Lewis in the latter portion of the same article and disposed of, by showing that the other restrictions depend for their justification upon grounds not set up in the case of the liquor-traffic.

Are we, then, to have an unrestricted sale, and is there no middle ground between that and prohibition, save license? Must we admit on grounds of morality that if we can not prohibit we must keep our skirts clean by refusing to regulate? The views put forward in the remainder of this article are advanced with diffidence because they are believed to be both original and new, and are a wide departure from any method which has been publicly proposed for the mitigation or removal of the evils of intemperance. The principle of high license, and, in a different relationship, that involved in the civil-damage laws, come nearer to them than anything heretofore suggested.

The quarrel that the public have with the liquor-seller is not that he furnishes the liquor-buyer with the means of injuring himself or the community. If it were, the public would have the same quarrel with the hardware-dealer who sells an axe to one who may cut himself or commit a murder with it, and with the grocer who sells matches to one who may use them to set fire to a public building. Its quarrel with the liquor-seller is that he furnishes to the liquor-buyer the means

of injuring himself and the public when he knows that it will be so used, and when he has reason to believe that it will be so used, not caring whether it is or not, and, further than this, that he does it for his own selfish gain. In short, the liquor-dealer sells his deleterious liquids for the purpose of profit with a full knowledge of their injurious tendency, and in utter carelessness as to the injury they may do. We find a recognition of the truth of this position in the provisions of the civil-damage laws, and in the restrictions placed upon licensees as to sales to minors and persons known to be drunkards.

Let us pursue this further by means of a couple of supposed instances, such as occur every day. John Smith has been, during the week, a capable and industrious workman, earning full wages every day. Saturday night he gets his pay and goes to the stores, where he falls in with boon companions and spends his week's wages at the grog-shop, standing treat and drinking himself until his money is gone. Late at night he is put out into the street drunk, the liquor-seller having got his money and being ready to close the shop. Result the first: The liquor-seller has received, say, twelve dollars, of which at least three quarters, or nine dollars, is profit. Result the second : Smith is arrested and put into the lock-up for the remainder of the night ; in the morning he is brought before a magistrate and fined one dollar and costs amounting to at least five dollars, and usually more, for want of which he goes to jail for ten days. Result the third : Smith's family applies to the overseers of the poor for assistance, and they, being unable to refuse, are likely to expend five or six dollars. Total results, leaving out the moral deterioration of Smith and his family, nine dollars profit to the liquor-seller, costs of prosecution paid by the county, Smith and his family supported at the expense of the town and county for ten days, and Smith's productive labor for ten days lost to the community.

At the least calculation, in order that the liquor-seller may make his profit, the community has lost much more than an equal amount. In this instance I have supposed the liquor-buyer to spend a full week's wages, but the contrast is still greater if we suppose, as is more frequently the case, that the buyer has only money sufficient to buy liquor enough to cause his intoxication ; that he is arrested and committed to jail for non-payment of fine and costs. The county then has the costs to pay, and the liquor-seller's profit is only a very small percentage of the expense he has caused the community. Let us attack his profit, wherever his trade is injurious to the public, and we shall be in a fair way to drive him out of the business altogether, or to oblige him to exercise such care in his management as to deprive it of its harm.

The first effect arising from the use of intoxicating liquor is drunkenness. It is proper that this offense against decency should be punished. Let the liquor-seller pay the expense of inflicting such punish-

ment, not the county. The next effect, following from numerous repetitions of the offense of drunkenness, is that the habitual drinker becomes the common drunkard. Whenever he is proceeded against let the liquor-seller pay not only the costs of the prosecution, but also those charges for his detention and support which the place of his settlement is now required to pay. As to the connection between crime and drunkenness as cause and effect I am not entirely certain. There is much to be said in favor of the view that the drunkard and the criminal are liable to be one and the same because the moral diathesis that tends to drunkenness also tends to crime; that intemperance and crime are coefficients, and that the criminal impulse is not the offspring of intemperance. There can be no doubt, however, that vastly the greater part of the abject poverty that requires the intervention of public assistance is the result of intemperance. For the purposes of the present discussion I claim that it all is. All such poverty the liquor-seller should be required to relieve.

There are, then, three classes of expenses thrown upon the community which arise as the direct result of the use of intoxicating liquor, and indirectly from its sale: the expense of prosecuting simple drunkenness, the expense of prosecuting and maintaining common drunkards, and the expense of supporting the poor; and these expenses should be placed where they belong—on the liquor-seller.

The plan, then, would be to grant licenses for the sale of intoxicating liquors to all applicants who are able to furnish bonds in a sufficient sum to pay their respective shares of the expenses mentioned as assessed upon them at the close of the year for which the licenses are granted. Whenever a person is prosecuted for simple drunkenness and is unable to pay the fine, an effort should be made to induce him, by a remission of a portion of his term of imprisonment or otherwise, to disclose the person from whom he purchased his liquor. His disclosure should become of record in the case. Whenever a person is proceeded against as a common drunkard, the place to which he has habitually resorted should be ascertained in the same way, if possible. After the end of the year for which licenses have been granted, the apportionment of the sums to be paid by every liquor-seller should be referred to some tribunal, which should examine the record in all prosecutions named above, should ascertain the costs of such prosecutions, and the expenses of supporting the poor throughout the district over which it is given jurisdiction. It should have power to apportion the sums to which such costs and expenses amount among all the licensees in such parts as seem to them, after hearing the parties interested, justly proportioned to the expenses which they have severally occasioned. How this tribunal should be formed is not now a matter necessary to be discussed, but it should probably not have a less extended jurisdiction territorially than a county. It might be composed of the county commissioners and one or more of the police magistrates.

Other ways of accumulating evidence, in addition to the disclosures of defendants, could be made use of, such, for instance, as recording the location of all arrests for drunkenness ; and it might even be well to provide that, in the lack of other evidence, the costs of any arrest and the succeeding prosecution may be set to the nearest licensed place of sale.

It may be claimed that the tribunal to make the apportionment will have a very difficult and invidious task to perform. Difficult it will be, but no more so than the task imposed upon juries in most of the cases contested before them, and invidious so far as the persons liable to pay are concerned. But there are two things clearly ascertained at the start, to wit, the persons liable to be assessed, and the amount for which they are liable. It must be remembered, also, that the tribunal will have the assistance of all the defendants themselves, who will be the very best witnesses in the matter, for every one of them will be anxious to tell all he knows about the others, in order that his own assessment may be as light as possible. There can be no common defense. The army of liquor-sellers will be divided against itself, and no longer united against the public. Combinations for and against legislation and the employment of counsel to obstruct the administration of the law will become useless.

One of the stock arguments in favor of license is that the lincensees in the interests of their own business will be vigilant to prevent sales by unlicensed persons. Experience has shown, I think, that this expectation has not been confirmed by the facts. The licensed seller is given permission to carry on a profitable business, in which all others are forbidden to engage under severe penalties, and this business is so profitable and the penalties are so effectual that it is never worth while for him to go to the trouble and expense of attempting to suppress the unlicensed dealer. He is entirely content with what the public will do for him in this direction. Under the plan proposed the suppression of the unlicensed seller becomes vitally important to the licensed, for the latter will be obliged to undergo the expenses occasioned by the former, in the same manner that the public now sustains the expenses occasioned by them both.

To recapitulate, in short :

Prohibitory laws have never wholly prohibited in fact, and are objectionable to many persons favorable to the cause of temperance on grounds involving the fundamental principles of legislation.

Under license laws we have a privileged class protected by the public in the exclusive conduct of a business which leads to burdens and expenses, which the public assumes, in effect saying to the licensees, "Go, and for your profit do us all the injury you please or find convenient, and we will not only pay the bills, but we will take care that no one interferes with you."

Under the plan proposed, the burdens and expenses arising from

the use of intoxicating liquor are placed where they belong—that is to say, on those who undertake to make a profit from supplying it; and they are under inducements to reduce such burdens and expenses to a minimum. It may be that no one will be willing to take the risk of engaging in the business with these liabilities, but for this I care not, for we should then have an unobjectionable form of prohibition.

ARISTOTLE AS A ZOÖLOGIST.

By FREDERIK A. FERNALD.

FOR over twenty centuries the philosophical writings of Aristotle have sustained his reputation as one of the greatest thinkers that the world has ever seen. Although he is generally thought of as a metaphysician and a logician, these names by no means denote the whole field of his labors. It was common for scholars in his age to take all knowledge for their province, and the limited attainments of the time allowed one writer to produce exhaustive treatises on every branch. To discover and state the laws of deduction with a completeness and accuracy which have left nothing to be added or taken away since would seem to be a sufficient labor for one man; but, besides doing this, Aristotle wrote considerable works on ethics, politics, rhetoric, physics, astronomy, physiology, and zoölogy. There is not the same unanimity, however, in estimating his scientific achievements as in the opinion of his writings on logic and speculative philosophy.

Aristotle's "History of Animals," says Buffon, "is, perhaps, even now the best work of its kind; he probably knew animals better, and under more general views, than we do now. Although the moderns have added their discoveries to those of the ancients, I do not believe that we have many works on natural history that we can place above those of Aristotle and Pliny." The laudatory language of the illustrious Cuvier is equally strong. Of the "History of Animals" he writes: "I can not read this book without being ravished with astonishment. Indeed, it is impossible to conceive how a single man was able to collect and compare the multitude of particular facts implied in the numerous general rules and aphorisms contained in this work, and of which his predecessors never had any idea." Again, "Not only did he know a great number of species, but he studied and described them after a vast and luminous plan which, perhaps, none of his successors have approached. . . . Everywhere Aristotle observes facts with attention." On the other hand, Lewes, in his essay on Aristotle, says: "It is difficult to speak of Aristotle without exaggeration—he is felt to be so mighty, and is known to be so wrong. History, surveying the whole scope of his pretensions, gazes on him with

wonder. Science, challenging these separate pretensions, and testing their results, regards them with indifference—an indifference only exasperated into antagonism by the clamorous urgency of unauthenticated praise. It is difficult to direct the opposing streams of criticism into the broad, equable current of a calm appreciation, because the splendor of his fame perpetuates the memory of his failure, and to be just we must appreciate both. His intellect was piercing and comprehensive; his attainments surpassed those of every known philosopher; his influence has only been exceeded by the great founders of religions. Nevertheless, if we now estimate the product of his labors in the discovery of positive truths, it appears insignificant when not erroneous. None of the great germinal discoveries in science are due to him or to his disciples." The question to be decided does not concern Aristotle's splendid and perhaps unrivaled genius, his logical power of thought, his love of truth, and his extraordinary diligence; it has reference to the claim made by Aristotle's too ardent panegyrists, that he discovered a system so perfect as to leave little, if anything, for us to alter, that in several instances he anticipated modern discoveries, and that his descriptions are marvels of accuracy and research. How far such statements are true must be discovered by the simple test of reading Aristotle's own words, and for this purpose some of the extracts employed to illustrate a recent comparison of the above conflicting opinions in the "Edinburgh Review" will be instructive.

Let us inquire how far Cuvier's statement that "everywhere Aristotle observes facts with attention" is true. In describing the elephant, Aristotle tells many things correctly, but some very incorrectly, so that it is a question whether he ever saw this animal in his life. He affirms that it has no nails on its toes, though he correctly refers to the toes, which are scarcely distinguished. The nails of the elephant are one of the "points" which the natives of India always regarded as marks of a well-bred animal, and are usually conspicuous. Let us take another point, the "gray-headed error" that the elephant has no joints. Aristotle says, "The elephant is not so constructed as to be unable to sit down and bend his legs, as some persons have said, but from his great weight he is unable to bend them on both sides at once, but leans either to the right side or the left, and sleeps in this position." That is to say, the elephant, having bent one fore-leg, can not then bend the other so as to kneel with both, which is contrary to fact. Although in this passage Aristotle demolishes the absurd statement that the elephant has no knee-joints, yet, in his treatise on the "Progressive Motions of Animals," he seems to leave the matter in doubt. After showing that without inflection there can be no progression, he says: "Progression, however, is possible without inflection of the leg, in the same manner as infants creep; and there is an ancient story of this kind about elephants, which is not true, for such animals move because inflection takes place in their shoulder-blades or hips." The

existence of animals without knees is again supposed by this remark: "Since the members are equal, inflection must be made in the knee, or in some joint, if the animal that walks is destitute of knees." If Aristotle had ever seen an elephant move, is it not probable that he would have spoken more decidedly and correctly on these points? But the most astonishing assertion is that "the elephant can not swim on account of the weight of its body"!

Aristotle's account of the camel is, on the whole, graphic and correct; he describes both the one-humped Arabian and the Bactrian species. He mentions the walk of the camel, stating that it moves with the hind-foot following the fore-foot on the same side. He twice repeats the statement that the camel has no teeth in the upper jaw. Doubtless he alludes to the front teeth; but the camel has two incisors in the upper jaw and two canines, so that Aristotle has not, as Cuvier asserts, "perfectly described and characterized the two species of camel." Among other strange notions held by Aristotle, apparently without any misgivings, may be mentioned the lion having no cervical vertebræ, but only one bone in the neck, its bones, which are small and slight, being without marrow, except a little in the thigh and fore-leg. In his work on "Parts of Animals," he joins wolves with lions in having one neck-bone, and gives as a reason, "Nature saw that these animals wanted the neck more for strength than for other purposes." Aristotle's notions with respect to the skull are peculiar; the brain is placed beneath the sinciput, and the occiput is empty—an error twice repeated. Women's skulls have only one suture, in the form of a circle. He mentions as an extraordinary thing the fact of a man's skull having once been seen without any suture, copying Herodotus in this, who says such a skull was found on the battle-field of Platæa. The skull-sutures in aged persons are frequently obliterated. Again, "The cranium of the dog consists of a single bone." He must have got hold of an old specimen. Certain abnormal deposits of bone which occasionally are found with diseased conditions of the heart in some of the mammalia were considered as necessary organs in the horse and some kind of oxen, "which on account of their large size have a bony heart for the sake of support." The seal and some swine are said to have no gall-bladder. The gall-bladder is by no means constant in the mammalia, and Aristotle is correct in saying it is not present in the elephant, stag, horse, ass, and mule. It is difficult to know what he means when he says that the Achaïnian stags appear to have a gall in the tail; we are quite in the dark as to what these stags are. In another place he mentions a stag of the same kind, which when captured was found to have a considerable quantity of green ivy growing on its horns as on green wood. Buffon seems to have thought this story possible.

That Aristotle placed too much reliance on the marvelous and impossible animal lore current in his age is obvious. Speaking of the

male stag shedding his horns he writes, "It is said that the left horn has never yet been seen, for the animal hides it because it has some medical properties." "When stags are bitten by the phalangium or other such creature, they collect a number of crabs and eat them." These statements are made by Aristotle without a single hint that he does not believe them. Had he regarded them as fabulous, it is probable that he would have so intimated, as he is in the habit of doing when he regards stories as "unworthy of credit." Mr. Lewes mentions Cuvier's instancing four generalizations to prove the immense acquaintance Aristotle must have had with particulars, and adds: "I will quote four others (forty might be found), all taken from the first book, which exemplify plainly enough how easily large and careful induction could be dispensed with: 1. The lion has no cervical vertebræ, but a single bone in its neck. 2. Long-lived persons have one or two lines which extend through the whole hand; short-lived persons have two lines, and these do not extend through the whole hand. 3. Man has, in proportion to his size, the largest and the moistest brain. 4. The forehead is large in stupid men, small in lively men, broad in men predisposed to insanity, and round in high-spirited men."

Aristotle's account of the halcyon, or kingfisher, is a curious mixture of fact and fiction, the latter largely predominating. He gives a good popular description of the bird, but says also: "Birds generally breed in the spring and the beginning of summer, but the kingfisher is an exception, for it produces its young about the time of the winter solstice; wherefore fine days which happen at this season are called halcyon days, seven days before the solstice and seven days after it, as Simonides has written, as when Jupiter in the winter month prepares fourteen days, which mortals call the windless season, the sacred nurse of the variegated halcyon. . . . These halcyon days do not always happen in this country at the season of the solstice, but they nearly always occur in the Sicilian Sea." He has some curious stories about eagles, and here, too, seems to depend upon the poets: "The eagle lays three eggs, but hatches only two, as is also related in the poems of Musæus, 'the bird which lays three eggs, hatches two and cares only for one.' Such things often occur, yet even three young ones have been seen in the nest. . . . The sea-eagle is very quick-sighted, and compels its young ones while still naked to look at the sun, and if one of them will not do so it beats it and turns it round; and the young one which first weeps it kills, the other it rears."

Among other curious zoölogical statements of Aristotle's which seem to receive his support, and which may be set down as current folk-lore of his time, are the following: "If any one make a noise as grasshoppers fly along, they emit a kind of moisture, as agriculturists say. They feed on dew, and if a person advances to them bending his finger and then straightening it, they will remain more quiet than if the finger is put out straight at once, and will climb up the finger,

for from bad sight they ascend it as if it were a moving leaf." "Persons who have parasites in the head are less subject to headache. Moths are produced in the greatest abundance if a spider is shut up with them in the wool, for this creature being thirsty dries up any moisture which may be present. Small birds during the day fly round the owl—which is called admiring it—and as they fly round it they pluck out its feathers." "The anthus" (some bright-colored bird) "is an enemy to the horse, for it drives the horse from its pasture and eats the grass; it imitates the voice of the horse and frightens it by flying at it, but when the horse catches it he kills it." "If any one takes hold of a she-goat by the long hairs of the beard, all the others stand still as if bewildered and gaze at her." "The hawk, though carnivorous, does not eat the hearts of the birds it has killed." "The jay has many varieties of voice; it utters a different one, so to speak, every day." "The goat-sucker flies against the she-goats and sucks them, whence its name. They say that, after the udder has been sucked, it becomes dry and goes blind." "Mares become less ardent and more gentle if their manes are cut. At certain times they never run to the east or west, always north or south." "The sow gives the first teat to the first little pig that is born." "When a serpent has taken its food, it draws itself up till it stands erect upon its tail."

Aristotle's reasons are frequently amusing. Man has no tail because the available formative material has been used up for the posterior parts. Apes have neither tail nor buttocks because they are intermediate between man and quadrupeds. Bees and wasps have stings inside their bodies because they have wings. All crabs and lobsters (generally) have the large claw on the right, because all animals are by nature strong on the right side. Bees and ants are more intelligent than other animals of the kind, because their blood is thin and cold. The seal has no external ears, only ear-pores, because its feet are incapacitated for walking. Serpents have a forked tongue because they are gluttonous, and a bifid tongue has a double tasting power. Man is the only animal that is tickled, because his skin is fine; and he is the only animal that laughs, and tickling is "laughter from a motion of this kind about the arm-pit," which, as Mr. Lewes says, is "a physiological explanation rather difficult to understand." Insects eat little because their bodies are cold. It is curious to notice that Aristotle had no idea that insects produced eggs; he said they bring forth worms, evidently taking the larva stage for the normal birth-form.

These instances are taken from the treatise on "Parts of Animals." It would be easy to supply many more of the same character, but surely these may incline us to deny that "in his accumulation of facts Aristotle has not written one useless word." It is certain from Aristotle's remarks, here and there, that he occasionally dissected animals, but he also mentions anatomical drawings as existing in his time, and

refers his readers to them. He could not, however, have dissected to any great extent, or he would not have made the erroneous assertions that he has on many points not difficult of demonstration. It seems to be chiefly among marine animals that he practiced dissection, and to which he paid most personal attention; certainly, many of his observations on sponges, crustacea, cephalopoda, and other sea-creatures, are admirably correct. To the question, did Aristotle dissect human bodies? his many misstatements seem to require a negative answer; at any rate, as Mr. Lewes remarks, "An answer in the affirmative would be still more damaging to his reputation, since it would render many of his errors unpardonable."

There seems much reason to believe that he paid little attention to examining the skeletons of animals, and that his osteological knowledge was very limited. Let us consider what he has recorded of a certain bone, well known to the Greeks as being one much used for dice and some other purposes. "Many cloven-footed animals," he says, "have an astragalus, but no many-toed animals have one, neither has man; the lynx has, as it were, half an astragalus, the lion one in the form of a coil; solid-hoofed animals, with the exception of the Indian ass, have no astragalus; swine have not a well-formed astragalus." The fact is that the hind-feet of all mammals possess this bone, with slight differences in form and relative position with the other tarsal bones, but always preserving its characteristic shape. Aristotle had a theory—a kind of physiological axiom—which led him to infer that certain animals could not have an astragalus, and he did not examine them to verify his theory; he was satisfied that his theory proved his facts, and that there was no need of verification. His argument, gathered from several passages, is mainly as follows: Large animals have in their system much earthy matter, the superabundance of which Nature uses in the formation of teeth, tusks, and horns. In solid-hoofed animals, as the horse, the excess of earthy matter goes to form the hoof, and not horns or tusks as it does in cattle and elephants; and, as this excess is spent in the formation of a solid hoof, such animals have no astragalus, which is only a kind of superadded bone, and would be, in the horse, for instance, a detriment rather than an advantage.

Aristotle had an ardent love and admiration of Nature, and in Nature he always saw the beautiful. He gives expression to this feeling in the following admirable passage from the "Parts of Animals": "Having already treated of these subjects, and given what is our opinion about them, it remains for us now to speak of animated nature, omitting nothing, as far as lies in our power, whether it be ignoble or honorable; for, even in those things which seem less pleasing to our senses in our contemplation of them, Nature, the creator of all things, affords inconceivable pleasures to those able to discover the causes of things and are philosophers by nature. For it would be unexpected and strange, indeed, if, when looking at images of things, we rejoice

when we survey the art that produced them, whether in painting or sculpture, and do not rather love the sight of the actual works of Nature when we are able to discover their causes."

Dr. Ferdinand Hoefer, writing on Aristotle in the "Nouvelle Biographie Universelle," says, "It is the part of men of genius to show equal superiority in every field," and many of Aristotle's eulogists write as if to abate one jot of this thesis would be treason to their idol. They outdo the zealous friend of Miles Standish in

"Praising his virtues, transforming his very defects into virtues,"

and are frequently carried into absurdities. To quote one other instance from Hoefer, "We find among others this remarkable (!) statement, that animate bodies are composed of air and water. As a fact, chemists have shown that all organic bodies are reduced by analysis to the elements of air and water (oxygen, carbon, hydrogen, and nitrogen)." Now Aristotle's notion of elements was that there were four, having respectively the characters of air, water, earth, and fire, or hot moisture, cold moisture, cold dryness, and hot dryness; and he conceived that animal substances combined the qualities of the first two. A glance at the percentage compositions of air, water, and an animal body puts Hoefer's coincidence in a still worse light. A favorite defense of Aristotle is to suggest that the erroneous passages have been interpolated—so sublimely confident are his disciples that Aristotle can not be wrong, and that what is wrong can not be Aristotle. Then, too, we are bidden to consider the state of science in his day. But, unless Aristotle made a decided *advance* on the state of science in his day, why call him a great naturalist? Just how much better he observed and experimented than the writers on natural science who immediately preceded him, it is impossible to say, since their books, to which he often refers, are lost. Certainly, he failed to record any adequate understanding and appreciation of these processes, and the world has had to learn them from later thinkers. His most ardent admirer will not claim to find in his writings an exposition of inductive reasoning to be compared with his exposition of the deductive process. His mind seems to have had such a pre-eminent command and comprehension of deductive reasoning—it was so perfectly adapted to run in deductive grooves, as it were—that it was incapable of more than the most imperfect use or conception of induction. Without a good command of the tools of science—observation, experiment, and induction—his scientific work could not be important.

But the reputation of Aristotle can well afford to dispense with these contested ascriptions. Sufficient remains unimpeachable to vindicate his title to a gigantic intellect, and let no one suppose that they who deny him equal eminence in widely unlike fields can be outdone in their honor of his real genius.

APICULTURE.

By ALLEN PRINGLE.

AMONG the recent industries of rapid growth in this country, bee-culture stands prominent. Of course, as a homely art, bee-keeping is no modern industry, being as old as history; but in its scientific developments it is of recent growth. In these times, when science is properly taking its place at the helm in all departments of human industry and activity, it is not strange that it is promptly assuming the guidance of bee-culture. This is a utilitarian as well as scientific age; and this is why bee-culture is being so rapidly developed, for its extraordinary growth is only in the ratio of its utility. Though known to commerce for twenty-five hundred years, hitherto it has been followed and known, in this country at least, principally as a local industry. But bee-culture, from the soundest economic considerations, ought undoubtedly to become a great national industry fostered and protected by the state. Apiculture is naturally a part of, and closely allied with, agriculture, inasmuch as the nectar gathered by the one is immediately derived from the same fields and forests that yield the abundant ingatherings of the other. Indeed, the bulk of the honey-crop of this country (which is, in round numbers, about 100,000,000 pounds annually) comes from the bee-keeping which is in connection, more or less, with farming.

But this is not the principal reason why bee-culture must take rank as an important national industry. The postulate is fully warranted by the following fact or facts: When the agriculturist takes his grain to market, he takes with it more or less of the *fertility of his soil;* when he takes his stock and dairy products to market, he does the same thing, only, perhaps, in a less degree. But, when he takes his honey to market, he does nothing of this kind—he takes none of the fertile elements of his soil along with it. When the skilled apiarist, guided by science, so controls, directs, and manipulates his bees that they gather the rich nectar in tons from a given area, representing hundreds and even thousands of dollars, he impoverishes neither his own land nor that of his neighbor: he simply secures that which, if not gathered, "wastes its sweetness on the desert air." Likewise, when a country exports its surplus grain or stock, it also inevitably parts with more or less of its fundamental agricultural resources; but its exported honey-surplus represents no corresponding impoverishment of soil. It would therefore seem clear that, from economic considerations alone, bee-culture ought to and must take its place among the most useful and important national industries.

There is also an æsthetic and hygienic side to apiculture, though in this practical and materialistic age mere sentiment must be subordi-

nated to utility. But the more advanced scientific bee-keeping of to-day may, without assuming much license or latitude, be called "one of the fine arts." To the cultured and æsthetic devotee of art proper in the recesses of his studio, who has never practically studied the nature and habits of the wonderful little honey-bee, and manipulated it from day to day, this claim for our beloved art may excite a smile. Nevertheless, the apiarian devotee who has studied, observed, and handled the marvelous denizens of his hives for twenty years will affirm his art, no less than the flavor of the nectar it produces, to be indeed *fine*. Ladies of high culture and refined tastes are engaged (and successfully too) in bee-culture with all the enthusiasm which is naturally inspired by a congenial and ennobling pursuit; and this is the best proof of our contention as to its æsthetic status. Being withal a healthful occupation, bee-culture invitingly offers itself to those in delicate health and not strong enough for hard physical labor. In numerous instances such persons, by engaging in this pursuit, have not only procured liberal means of subsistence, but have also recovered lost health and strength. The capital required is comparatively small, while the average return for skilled exertion is large. Hardly any other legitimate business yields so large a return in dollars and cents for the amount invested and the work bestowed. True, bee-keeping has its formidable obstacles and serious drawbacks; but these, while sometimes troublesome to the scientific apiarist, are disastrous mostly to the unskillful or negligent, or the mere neophyte. And even though the cargo of industry sink, not much treasure in money or labor is carried to the bottom, while a very little capital added to the valuable lesson of failure soon sets the redoubtable amateur on his legs again.

The honey-bee—which belongs to the general branch of the animal kingdom called *Articulates*, and to the class *Insecta*, and to the sub-class *Hexapoda*, and to the order *Hymenoptera*, and the family *Apidæ*, and genus *Apis*, and species *Apis mellifica*—is one of the most intensely interesting studies in the whole domain of natural history. When the immortal Darwin had the scientific zeal and patience to study the apparently insignificant *earth-worm* for *forty* long years, leaving a field untouched for thirty years for the purpose of studying and observing the habits of these despised creatures, how comparatively easy and pleasant to study the honey-bee, which is so much more useful and beautiful! The fact that the honey-bee is so much more serviceable to man than many others of the lower creatures whose nature and habits are equally wonderful, as the ant, for instance, invests it with a double interest to us. Insects which are pests, no matter how marvelous in structure and habit, we can not study with that intense pleasure and interest we can those that yield so much to our physical as well as mental gratification.

Of the species *Apis mellifica* there are many varieties—the principal of which are the Ligurian or Italian bee; the German or black

bee; the Syrian bee; the Cyprian bee; the yellow, Egyptian bee; the amiable, Carniolan bee, of Africa; the superbly beautiful Dalmatian bee; the Smyrnian bee, very popular in Austria; and the stingless bees of South America.

In this country (i. e., Canada and the United States) we have principally the German and Italian bees; but within the past five years the Syrian and Cyprian varieties have been extensively imported into this country by that distinguished and enterprising apiarist, D. A. Jones, of Beeton, Ontario. As the genus *Apis* is not indigenous to this continent, all now existing here have been introduced from the Eastern Hemisphere—first, the black and Ligurian races, and latterly the Eastern varieties.

Each of the varieties now in this country (vying for "survival" as the "fittest") has its distinguishing characteristics. So far, however, the Italians seem to possess more good points and desirable qualities than any of the other races, and hence are the most numerous and popular among advanced apiarists. Their chief distinguishing qualities are superior amiability, industry, and what may be called patriotism, or indomitable energy in defending their homes against invaders, such as robber bees and the "bee-moth"—against both of which they are quite invincible. While different strains of this variety vary considerably in color, they are in general distinguished by three beautiful yellow bands across the abdomen. They also have longer tongues than the German bees, by which they are enabled to sip the nectar from places inaccessible to their less favored competitors. A. J. Cook, Entomological Professor in the Michigan Agricultural College, who has done very much to advance scientific bee-culture in the United States, says on this point, "The tongue of the black worker I have found, by repeated dissections and comparisons, made both by myself and by my pupils, is shorter than that of the Italian worker, and generally less hairy." * In confirmation of this fact, established by Professor Cook's dissections, I have frequently noticed my Italian bees, during a scarcity of honey from other sources, working upon the second bloom of the common red clover (not the *Trifolium pratense*, which the black bee can readily work upon), when the German bees were doing nothing on it, the flower tubes being too long for their tongues.

The black bees (or rather, German, for in point of fact they are not black in color, but a gray-black) have some desirable qualities, though they are now being rapidly superseded by the Italians. They produce nicer comb-honey than the Italians, or perhaps any other race. The proverbial whiteness and finish of their comb are due mostly to the extra *capping*.

For the Syrian races of bees, Mr. Jones and some other leading apiarists claim some superior qualities. I am inclined to think the

* "Bee-Keeper's Guide," ninth edition, p. 35.

Syrian queens (Palestine strain), crossed with the Italian drones, will presently prove to be our very best bees—combining more good points than any other existing variety. Doubtless, however, the bee of the future will be greatly superior to anything we have at present. For purposes of experimentation in developing such, we have now in America several of the best varieties in existence under domestication. By judicious crossing, in accordance with the well-known laws of *variation* and *heredity*, such a result is quite certain. The vast improvement made in this way among our domestic animals, within less than half a century, fully warrants the conclusion that, in the evolution of things so palpable everywhere, we may in the case of our bees subsidize and utilize the same ever-acting law of progress.

Following the Syrians, and genealogically closely allied to them, we have the Cyprians, though not yet widely diffused. They resemble the Italians, of which they are supposed to be the progenitors. The Cyprian bees have some good points, and one very bad *point*. They are famous for their fecundity, but equally *in*famous for their ferocity, being maliciously expert in using very pointed stings. This variety (unless in this inspiriting western atmosphere it acquires more amiability) is not likely to become popular, notwithstanding the marvelous fecundity of the queens. It may be possible, by crossing with some bee of good disposition, to mollify their bad tempers and retain their good qualities.

Of the remaining varieties of the honey-bee, and sub-varieties, including *hybrids*, little is practically known in this country, with the exception of one or two strains of the latter. The "hybrids," resulting from a cross between the Italian queen and the German drone, are well known in Canada and the United States, and, next to the pure Germans and Italians, are perhaps most numerous. These hybrids have excellent qualities: they make superb comb; are active and energetic; and I have observed stand the rigor of our Canadian winters much better than the pure Italians; but they are much less amiable.

A properly constituted colony of bees consists of three different kinds, viz.: an impregnated *queen* (the fully developed female); *drones* (the males); and *workers* (undeveloped females). The queen (absurdly called the "king-bee" from the time of Aristotle and even Virgil down to Huber) is the mother of the whole colony, and is capable of laying over three thousand eggs per day! During the height of the breeding-season in the honey-flow, she frequently lays from two to three thousand eggs per day for many consecutive days together. She remains prolific for from two to four years, and in some instances queens have been known to remain prolific upward of five years. Before the queen-bee of a colony becomes quite barren, and while she is still laying, if not removed by the apiarist, the workers themselves supersede her, by killing her and rearing a young

queen to take her place. Sometimes, however, the old, worn-out mother is permitted to remain in the hive while the young one is being reared, and ultimately dies of neglect and depression, or is assisted to "shuffle off" by her own unfilial progeny. The queen is reared from the same egg as the worker, but in a much larger cell, nearly perpendicular, and on different food, called "royal jelly," which has the effect of fully developing the sexual apparatus. The time from the egg to the perfect queen emerged from the cell is about sixteen days. In a few days after hatching, the young queen leaves the hive for her "bridal flight," during which, and on the wing, she meets the male bee or drone in copulation and becomes impregnated, when she returns to the hive to remain there until she leads out the first swarm, which she does when she finds young queens being reared in the hive—one of them designed to take her place. A *single* fertile queen in a colony is the normal condition of the household, and hence the old queen departs to make room for her successor. Second and third swarms are of course led out by the young queens. With the exception of sometimes attacking and destroying inchoate queens, the sole function of the queen is to deposit eggs and lead out the first swarm. After her impregnation she deposits both drone and worker eggs—either kind at pleasure. She is capable, however, as a virgin queen, of laying fertile drone, but not worker, eggs. This apparently anomalous fact (*parthenogenesis*) is now well established, not only in the case of the virgin queen-bee, but in that of several other insects. Sometimes *worker*-bees in queenless colonies lay fertile drone-eggs; but the queen is the only fully developed female in the colony.

The worker-bees, though "the bone and sinew" of the hive, are not blest with the queen's longevity. In active work, on the wing and off, during the honey-season, they naturally live but a few weeks—from one to two months—while those hatched late in the fall will live until spring, sometimes reaching the age of nine months and upward, which is the maximum longevity of the worker-bee. In passing from the egg to the perfect bee, the worker occupies twenty-one days. The young worker spends several days (from ten to fifteen) at home building comb, attending to the young brood, receiving and depositing the loads of the outside workers, and sundry other little duties, before it ventures to the fields to work. The duties of the older workers of the colony are to gather honey, pollen, and propolis, destroy and cast out the drones when necessary, and defend the colony from enemies without or within. They also, as already noticed, destroy old, unprolific queens and rear young ones to take their places, and sometimes lead out in swarming, as the queen does not always take the lead in swarming. And although very young bees are ordinarily very reluctant to leave the hive, I have seen such rush out under the swarming impulse so young that they couldn't fly more than a foot or two, if at all. They usually crawl back home again in apparent disgust

with the outside world, and doubtless with more wisdom and less conceit.

The third and last rightful denizen of a perfect colony of bees is the unsophisticated, stingless, but much abused *drone*—the male bee. He is well named, however, being a very liberal feeder with excellent digestive organs for honey, and with no duties whatever within the hive further than the incidental one of contributing by the presence of his cumbrous corporation to the animal heat of the hive. As to his natural longevity, nobody from Virgil to Huber, Langstroth, Quinby, Newman, Cook, Jones, *et alii*, seems to know much about it. The matter not being invested with any importance, no investigator seems to have bothered his head much with it. So far as I could ever see, the drone seems to live and thrive admirably until he is either killed off by the workers, starved to death, or gallantly yields up his life in performing his sole function, which he invariably does in the performance of this function in the act of copulation. The drone, as Dr. Dzeirzon established, comes from an unimpregnated egg—the virgin queen, and sometimes even workers, being able to lay eggs which will produce drones. As a rule, drones are found in colonies whenever they are needed, or likely to be needed to impregnate the young queens, which is usually during the swarming season and honey-harvest. Though they are promptly ejected from strong colonies when not needed, and the honey-flow fails, they are tolerated in queenless colonies, and are sometimes wintered over. The drone is much larger than the worker, and his cell very protuberant, and in it he spends twenty-four days from the egg before he emerges.

As remarked at the outset, bee-culture made but little progress on scientific principles for thousands of years. It is only within the last half-century or so that it has, under the magical talisman of science, fairly leaped forward like every other pursuit. The first great achievement was the application of the centrifugal force in the construction of the honey-extractor, thus enabling us to get the honey in its purity out of the comb without injuring the latter, when it can be returned to the bees to be refilled. A German (Herr von Aruschka) accomplished this, and thereby gave a great impetus to bee-culture. Indeed, the invention of the *movable frame* and the *honey-extractor* completely revolutionized the *modus operandi* of bee-keeping. As to who is really entitled to the credit of inventing the movable frame, there is some uncertainty and a conflict of claims. The truth seems to be that some three or four different persons are fairly entitled to credit—each, it would appear, having conceived and developed the idea, more or less independently of the others. Huber and Schmidt in Germany, Munn in England, M. de Beauvoys in France, and Langstroth in the United States, are all fairly though not equally entitled to credit, and each has placed progressive bee-culture under tribute. Mr. Langstroth, however, seems entitled to much more credit than any of the others,

for his hive had more practical value than the whole of the others together. In carrying out the common principle, Langstroth was undoubtedly far ahead.

The next stride in advance was the invention of the manufacture of "comb-foundation," which was a great desideratum, as the honey-season in the temperate zone is comparatively short, and a new colony of bees supplied with the "comb-foundation" will do as much in two or three days as one alongside of it without the foundation will do in eight or ten days, as the writer has repeatedly proved. Foundation-comb is made by pressing sheets of pure bees-wax between metal rollers or plates so constructed as to give to the wax the exact impressions of the cells in the basal wall of the natural comb. This saves the worker-bees just that much labor and time, and they proceed at once to rapidly draw out and develop the incipient cells. The merit of this invention is also somewhat in dispute. Upward of twenty years ago the late eminent apiarist, S. Wagner, patented comb-foundation in the United States; but it soon transpired that Herr Mehring, in Germany, had previously made foundation, and that the Germans had been using it for three or four years. As it is the accumulated wit and experience of the age, rather than the man, that produces the invention, it is quite likely that Mr. Wagner arrived at the idea without the aid of the other German (for Mr. Wagner was himself a German). Montaigne said he "had as clear a right to think Plato's thoughts as Plato himself had"; and the American German had not only as good a right as the home Teuton to think out this invention, but he was just as likely to do so, and more likely, for the inspiriting and inventive Yankee atmosphere would quicken his blood and sharpen his wits.

Recent bee-culture has been also greatly promoted and extended by the specialty of queen-rearing, which has been brought to great perfection on scientific principles. D. A. Jones, in Canada, and Henry Alley, in the United States, have developed this department of apiculture to an extent leaving, one would think, little to be further achieved or desired. As, however, under the progressive laws of evolution, we have ceased to set bounds to improvement in anything not fixed mathematically, we will not say that any department of practical apiculture is yet fully wrought out to perfection.

In order to secure absolute purity of fertilization in the different varieties and sub-varieties in crossing, D. A. Jones, of Beeton, Ontario, has established queen-nurseries on different islands in Georgian Bay, so far from shore and from each other as to secure entire purity of blood in copulation. Queens and drones bred and mated under such circumstances, from pure imported stock, can not be otherwise than pure.

Henry Alley also, of Wenham, Massachusetts, has, through a long series of experiments during many years, successfully applied science to the *modus operandi* of queen-rearing, and has recently given the

world the fruits of his labors and researches in a work entitled "The Bee-Keeper's Handy-Book; or, Twenty-two Years' Experience in Queen-Rearing."

Another feature of present bee-culture, which is at once both largely the cause of its present advanced condition in this country and the best proof of its wide extension, is its periodical literature. Devoted wholly or partially to apiculture, we now have no less than three or four papers in Canada, and nearly a dozen in the United States. Among the latter is one *weekly* devoted *exclusively* to bee-culture. This is the "American Bee Journal," published in Chicago by Thomas G. Newman. Among the former is the "Canadian Bee Journal," a weekly, just commenced under the most favorable and promising auspices. It is edited and published by D. A. Jones, of Beeton, Ontario.

Since the hitherto great difficulty of successfully wintering bees in these climates has been nearly overcome by the application of science, bee-culture must, in the near future, become a great and profitable national industry in Canada and the United States.

STRUCTURE AND DIVISION OF THE ORGANIC CELL.

By CHARLES MORRIS.

THE doctrine of the cell, as the unit of vegetable and animal structure, has been constantly varying in its details since its first proposal by Schleiden in 1837 and Schwamm in 1839. It was at first held that the cell was a microscopic vesicle, globular in its typical form, bounded by a firm membranous wall, and inclosing fluid or semi-fluid contents. In its interior lay a smaller vesicle called the nucleus, which occasionally held a minute mass called the nucleolus. The cell-wall was believed to be its active constituent, which selected materials from the surrounding fluid for cell-nutrition, and set up physical and chemical changes within its contents. At a later date Goodsir and Barry maintained that the nucleus was the active agent in these processes, and that self-division of the nucleus was the source of cell-division. It was also perceived that a cell-wall was by no means always present, and Leydig defined a cell as "a little mass of soft substance inclosing a nucleus." A more important step of progress was made about 1861, when Von Mohl, Brücke, Max Schultze, Beale, and others, propounded their views upon the subject. Brücke pointed out that the contents of cells frequently displayed spontaneous movement and contractile power; and Max Schultze declared that sarcode—the contractile substance which forms a large part of the bodies of the lower animals—was homologous with the contents of actively growing cells. Von Mohl had proposed the term protoplasm to designate the

active substance of vegetable cells. This term was extended by Max Schultze to embrace all organic cells, and he defined the cell as a nucleated mass of protoplasm. At a still later period it was declared that a nucleus was not always present, and the cell was defined as "a structureless mass of protoplasm."

Such was the stage of the cell-doctrine reached in 1872, thirteen years ago. First the cell-wall had been considered the active element, then the nucleus, and finally the protoplasmic contents, while wall and nucleus came to be considered inessential elements. As Drysdale expressed it about that date, "a cell is like a gun-barrel, without a stock and a lock." Meanwhile Beale had persistently declared that there is no such thing as a cell, in the ordinary sense of the term; but that all organic bodies are made up of minute particles of living or germinal matter, which consume nutriment and increase internally, while their exterior portions lose vital activity, and become dead or formed material. These living particles not only grow, but divide, and thus set up new centers of growth, from which emanates new-formed material.

The division of the cell-protoplasm is, indeed, a most essential part of the life-process, and to it growth and differentiation of tissue are principally due. The cell, when furnished with nutriment, manifests individual growth for a short period. Then it separates into two or more new cells, each of which sets up an individual life. This separation takes place in several methods, of which the most common is by an equatorial constriction, which gradually deepens until it cuts the cell into two sections. Other methods are by the budding off of minute portions from the surface, or the transformation of the cell-contents into many minute germs, which are subsequently set free.

Such was the cell of thirteen years ago—"a structureless mass of protoplasm," which increased in size by nutrition, and in numbers by division. Such is the cell of most of the text-books of to-day. But the cell of science is a very different affair. Instead of being structureless, it is found to possess an intricate structure, while its division is far from being the simple process above indicated. The new cell-theory is, in fact, but five or six years old in its developed form, and it is as yet settled only in its main features. Its minor details need much further elucidation.

These new discoveries, which we shall briefly describe, are largely due to the increased power and clearness of definition of the microscope, and still more to new and improved methods of preparing organic sections for investigation, by the employment of stains, preserving agents, and other useful appliances. It is not every microscopist that is able to see the minute details of cell-structure lately announced. The careful preparation of material and exceedingly delicate manipulation required need years of practice, and the discoveries referred to are due to the first microscopists of the age, though the methods are now so

simplified that any skilled observer, with a good instrument and proper care, may hope to successfully employ them.

The matter of which an organic cell is composed is found to be not simply a homogeneous, or slightly granular, mass of protoplasm. On the contrary, it appears to be traversed in every direction by delicate fibers, which form an intricate network or reticulum. The interstices of this network are occupied by a fluid or semi-fluid substance of homogeneous appearance, though occasionally containing a few small granules. The reticulum occurs not only in the outer cell, but also within the nucleus, and its fibers extend to and are apparently connected with the nucleolus. Within this latter the fibrous formation has not been traced. Some observers, indeed, declare that there is no nucleolus, but that it is simply a node of the intersecting fibers. But this view is not generally entertained, and late writers ascribe to the nucleolus an important function.

In the growth and division of the cell the nucleus appears to be specially active, and the new doctrine known as karyokinesis relates principally to the peculiar metamorphoses of the nucleus during cell-division. Two phases of cell-life are now well marked. One of these is an active stage, during which transformation of the cell-contents rapidly takes place, and division follows. This is succeeded by a resting-stage, in which all activity of the nucleus ceases, the fibers grow less distinct, and a partly homogeneous condition results. This resting-stage is, after a period, followed by a new period of activity.

The behavior of the cell-contents, when treated with carmine or other staining reagents, indicates that they are composed of at least two distinct substances. During the resting-stage this does not appear, for the whole cell takes the stain, though it deepens in the nucleus, and still more in the nucleolus. But during the active stage only the fibers take the stain, while the intermediate ground or basis substance remains clear and transparent. From this difference in behavior the name *chromatin* is proposed for the fibers, *achromatin* for the ground substance.

Flemming, one of the most skillful observers of these phenomena, distinguishes two forms of division—the direct and the indirect. The former—which may eventually prove to have no real existence—is a direct separation, first of the nucleolus, then of the nucleus, and finally of the cell. In the latter there is a peculiar metamorphosis of the nucleus. Flemming, from observation of the cells of Salamandra, describes the process as follows:

The resting-nucleus possesses a faintly-defined reticulum of fibrils, whose meshes hold a homogeneous ground substance, one or more nucleoli, and occasionally a few small granules. Possibly these latter are merely the nodes of the reticulum. When the active stage commences, the membrane of the nucleus disappears, as also the nucleolus and the granules. If the latter are merely nodes of the fibrillar network, we

can understand their disappearance, for the fibrils lose their net-like reticulation, and become an irregular convolution, with no free ends. Around this fibrous nuclear mass appears a clear space, which separates it from the outer cell-substance. As thus arranged it forms what has been called the *aster*.

Soon the fibrous convolutions assume a wreath-like arrangement, with their bends irregularly directed toward a central space. Eventually the wreath loses its continuity, and breaks into a series of short, separate fibers, which form V-shaped loops. The bends of these loops are directed toward the center space, their openings outwardly. This arrangement forms the *mother-star*. Next there is shown a doubtful appearance, as if the fibers had split into two, or had become tubular. The loops are also compressed toward the equatorial plane of the nucleus, and lose their extension toward its polar region. After some further dubious movements, a rearrangement of the loops is found to have taken place, their bends being now turned outward, their openings inward toward the equatorial plane. They have also separated in this plane, so as to form two distinct masses, one on each side of the equator. If we consider the cell as a globe, and the equatorial plane as a circular disk dividing this globe into two hemispheres, then on each side of this disk lies a smaller circle of fibrous loops, which present something of the aspect of a circular basket, or of a partly-opened daisy. The openings of these basket-like figures are turned toward each other, with the equatorial plane separating them. The converging looped ends of the fibers are turned outward.

This stage in the process of division of the nucleus is followed by a recession of the basket-figures. They retreat in the axial line of the cell until they reach the polar regions of the nucleus. Here a rearrangement of the fibrous loops takes place, their bends again become directed toward a central space, and two new stars, similar to the *mother-star*, are formed. The division of the chromatin, or fibrous substance of the nucleus, has become complete, and the whole new arrangement is known as the *dyaster*.

As the basket-like figures recede, there often appear in the interval between them delicate striæ, which cross the equator from pole to pole. This condition, which is most declared in vegetable cells and in segmenting ova, is known as the *nuclear spindle*. The lines of the striæ seem to be composed of achromatin. Other faint lines often radiate from the poles toward the surface of the cell, forming sun-like figures at the extremities of the nuclear spindle. Complete division is preceded by the appearance of a row of dots across the equatorial plane, which seem to be thickenings in the centers of the lines of the spindle. These thickenings are probably composed of chromatin, and form what is called the *equatorial plate*. They soon divide, the spindle separating in its center, while the thickenings appear like minute disks at the extremities of the nuclear striæ. Thus a double equa-

torial plate is formed, inclosing a narrow equatorial plane. This is the plane of cell-division. A furrow appears around the equator of the cell, which deepens, and extends inward between the equatorial plates. It continues to deepen until it finally meets in the center, and the cell is separated into two new ones.

While this is proceeding, new nuclei are forming at the nuclear poles. The fibers of the daughter-stars pass through a series of changes opposite to those above described. The ends of the loops unite until a wreath is formed. This wreath soon becomes an irregular convolution, which quickly assumes the reticular structure. Membranes form around the new nuclei. Nucleoli and granules reappear. The resting-stage is regained. The original cell is replaced by two daughter-cells.

The above description, with its detailed account of the process of cell-division, is not accepted in all its particulars by other observers. There is great diversity of opinion about many points, which can not be settled without much further investigation. It is also very probable that much of the diversity of opinion arises from the fact that the cells of different organisms vary in their features of change, and that vegetable cells only distantly resemble animal cells in this particular.

Some of the unsettled questions are the following: Klein and Strasburger see little importance in the nucleolus. Klein doubts its existence. There is an open question whether it and the granules are not merely the nodes of the network. But the majority of observers speak of the nucleoli and granules as lying free in the ground-substance, in the intervals of the network. It is also a question whether or not the outer cell-substance is like the nucleus in structure. Klein holds that it is. Flemming has lately announced the discovery, in the resting-nucleus, of a very fine network, in connection with the coarser one already known. He also declares that the membrane surrounding the nucleus is really composed of minute flat plates of chromatin continuous with the fibrils of the network. These are separated by slight intervals, so that the membrane seems pierced by holes, which perhaps may be occupied by the transparent ground-substance. Others deny the existence of a nuclear membrane, and think that it is an optical illusion, caused by the arrangement of the fibers. Dr. Pfitzner has recently declared that the chromatin fibrils are not homogeneous in structure, but that they really consist of minute spherules of chromatin, held together by some other substance, probably achromatin.

Such are some of the questions to be yet settled. It would appear that the chromatin of the original nucleus becomes first regularly arranged around its center, then divides equatorially and recedes to its poles, where it forms new nuclei, while the achromatin-fibrils of the spindle may possess some chromatin, which collects upon their centers to form the equatorial plate. If Flemming's last observation concern-

ing the formation of the membrane be correct, it may prove that the disks of the spindle-fibrils are the origin of the cell-wall, and that similar disks arise at the extremities of achromatin-fibrils in the new nuclei to form their membranes. And Pfitzner's observations would indicate that the fibrils are really composed of achromatin, upon which chromatin gathers either continuously or in separate spherules. In such a case the movements of chromatin would be along lines of achromatin; and we can comprehend the appearance of the lines of the achromatin-spindle, after the chromatin has aggregated at the poles, and also of the chromatin-disks which are shown equatorially on these lines. The chromatin of the fibrils has aggregated at the poles and the equator of the nucleus, and left apparent intermediate lines of achromatin.

In vegetable-cell divisions Strasburger finds none of this regular process, but only a vague approach to it in the movements and aggregations of masses of chromatin. But the achromatin-striæ of the nuclear spindle, the equatorial plate, and the sun-like polar rays, are well declared. In some cases of abnormally rapid nutrition a threefold division takes place, and possibly a still greater number of new cells may be formed. The process of cell-budding may be similar to that above described, if we can judge from observations on the early transformation of the ovum. Here a nuclear spindle is formed, with its polar suns. This moves to the surface of the cell, and one of the poles is pushed out through its wall. Constriction takes place, and the new nucleus remains on the outer surface of the cell as the *polar body*, while the other nucleus retreats to the center of the ovum. The process is precisely analogous to ordinary cell-division, the difference being that one of the new nuclei retains around it all the substance of the original cell, while the other is destitute of it. Did this polar body become free, and grow by absorbing new nutriment, the resemblance to ordinary cell-budding would be complete. Frequently two or more polar bodies are thus formed ere fertilization of the ovum takes place. Possibly the cell buds off its male element and retains only its female. An analogous process takes place in the spermatozoa. It would seem as if the germinal cells were becoming specially male and female in energy ere combining to form the germ of a new individual.

Recently Mr. J. M. Macfarlane, of Edinburgh, has published an interesting paper, descriptive of vegetable-cell division. His observations were made on the cells of *Spirogyra*, a common fresh-water alga. The large nuclei of these cells seem specially adapted to observation. He found not only that the nucleolus was very distinct, but that it invariably contained a well-defined body, which he names the *nucleolo-nucleus*. He found this body in all plant-cells examined, and also in cerebellum-cells of animals. In staining with carmine the stain hardly affected the outer cell-substance, the nucleus took a somewhat deeper stain, the nucleolus was deeply colored, and the nucleolo-nucleus still

more deeply. The density of the chromatin appeared to increase inwardly.

From the outer cell-wall fibers pass inward to the nuclear membrane, which they probably penetrate, and become continuous with the fibers of the nucleus. These, in their turn, seem to connect with what appears to be a membrane of the nucleolus. Inside the latter there is no evidence of fibrous structure.

In cell-division the first stage is the aggregation, on opposite sides of the nucleus, in a line with the long axis of the cell, of a quantity of pale, slightly granular protoplasm. This is perhaps derived from the peripheral layer, and travels inward along the fibers, since minute thickenings, of similar appearance, show themselves upon these fibers. The nucleolus swells out into two protuberances, in the same axial line, joined by a bridge of denser matter. This change is, perhaps, connected with the division of the nucleolo-nucleus, since subsequently two of the latter are visible, while the nucleolus returns to its former state. At the same time it is found to have considerably increased in size. The next visible change occurs in the nucleus, whose contents aggregate at the nuclear poles, push through the membrane, and combine with the outer aggregation of protoplasm to form two dark amœboid lumps. From these polar masses fibers run inward and outward, though the external fibers have become loose and flaccid.

In the next stage the nuclear membrane disappears. The spindle of fibers which runs inward to the nucleolus is bordered by two darker strands, possibly the remnants of the membrane. This composes the *nuclear barrel.* The nucleolus divides by a dumb-bell-shaped constriction, similar to what appears in the division of amœbæ. It resembles what Flemming calls "direct division." The two halves of the divided nucleolus—each containing one of the nucleolo-nuclei—now move outward toward the poles, a new line of fibers forming between them as they separate. These bodies almost seem to have a repulsive energy, for the polar masses recede before them. The connecting lines also spread outward centrally, so that the nuclear barrel becomes considerably elongated and widened. It resembles a barrel with thick, narrow ends and widely swelled-out middle. Eventually the nucleoli reach the polar masses, into which they penetrate, while the substance of the latter spreads inward so as to inclose them. The rudiments of new nuclei are thus formed, between which extend rows of fine fibrillar lines, much separated centrally. The "nuclear barrel," with the nucleolus in its center, has thus been succeeded by the "nuclear spindle," with no central mass.

There now appears a row of dots, stretching across the equator of the spindle. This quickly separates into a double row. At the same time the lines of the spindle are sundered centrally, and the dots seem to be minute disks at their extremities. In this manner a double "equatorial plate" is formed, inclosing the circular equatorial plane of

the cell. Around the cell-wall, in this plane, is seen a faint ring, which pushes inward, and develops into a new wall of cellulose. It extends into the space between the two equatorial plates, and continues to grow inward until the center is reached, when it forms the dividing wall of the two new cells. As it grows, the spindle, which had previously been swelling outward, begins to contract, until it becomes a narrow series of lines, reaching from the poles to the new cell-wall. Meanwhile the polar masses secrete new membranes, and assume the condition of nuclei of the new cells. So rapid is the process that the nucleolo-nucleus often again divides ere the nucleus has completed its division, and the nucleoli again divide ere the new cells are formed. Hence the new nucleus often has two nucleoli. After complete division the lines of the nuclear spindle are still apparent. They may, by splitting, give rise to the fibers of the new cells.

Such is a recent description of the process of division in the plant-cell. In the cells of some plants, however, there is a preliminary step of change which does not appear in *Spirogyra*. In these cases division begins with a massing of the nuclear contents in the equatorial region. The nucleus has a spindle-shape, with a dark mass in its center, and clear areas reaching to its poles. This mass splits, and its two halves retreat to the poles. The further steps of division are as above.

Thus, so far as now appears, the process of cell-division in the plant is closely analogous to, though not identical with, that of the animal. It seems, indeed, a more primitive stage of the phenomenon. The division of the nucleolus, so marked in the plant, has not been observed in the animal, and may be, in the latter, suppressed or hastened, like many of the developmental changes in the higher animals. On the other hand, the peculiar movements of the chromatin-fibrils of the animal cell have no direct counterpart in the plant. They seem to present a distinct step forward in cellular evolution, and yield the idea that the animal cell is a more advanced organism than that of the vegetable. It certainly seems to hasten or suppress embryo changes which are well marked in the latter, and to clearly display advanced stages of development which are only vaguely outlined in the latter.

There is another cell-theory extant to which some allusion must be made, as it indicates a final stage in cell-evolution in advance of that here indicated. It is known that in many cases elongations of the fibrous network extend outward from the cell. These have been seen in epithelial cells, joined so as to form a connecting link between two cells. It is well known also that numerous delicate fibrils extend beyond the walls of nerve-ganglion cells, probably as outer continuations of the internal network. It is supposed that these fibrils aggregate into bundles, and that thus the nerve-fibers, which run to all parts of the surface of the body, originate. This seems to be the cell connection of the sensory nerves, while the motor nerves leave the cells each as a single fiber. The nerve terminations of muscles present a

similar condition, since they probably penetrate the cells as minute fibrils.

C. Heitzmann, a skilled microscopist, now of New York, has long maintained, and has recently reiterated, a theory which declares that this fibrillar extension is not confined to epithelial and ganglion cells, but is common to all the cells of the body, and that intimate interconnections between all the cells and tissues are thus made. Even the bony structure he declares to be everywhere permeated by fine channels, in which run fibrils of protoplasm, connecting the granular and nuclear masses throughout the whole substance. He, indeed, denies the existence of separate cells, and claims that the body is simply a vast reticulum, with nuclear masses as nodes of the network. Instead of being composed of numerous separate amœboid cells, it is a single complex amœba.

This bioplasson theory is not accepted by microscopists generally, and it certainly goes too far in denying the existence of distinct cell-structures. It may be possible that it indicates a final stage in the process of cell-evolution. Distinct isolated cells undoubtedly exist in the blood and lymph fluids of the body. But in the more solid tissues this isolation is, in some cases at least, replaced by an interconnection of cells through the medium of inosculating fibrils. And it is quite possible that this fibrillar extension becomes so declared in extreme cases as to produce the appearances described by Heitzmann. The basis or ground-substance of the outer cell of osseous tissue may be converted, by deposition of lime-salts, into bony matter, through which the fibrils extend from the nuclei in open channels. If this theory be correct, the original cell becomes a nuclear center of active protoplasm and an outer region whose ground-substance is converted into bone, while its protoplasmic fibrils extend until they join similar fibrils of other cells, thus converting the whole mass into a living network whose interspaces are occupied with bone.

In other tissues a similar condition may exist, the bony matter of the osseous ground-substance being represented by other inactive material proper to the tissue. Perhaps every phase of differentiation exists, from the completely isolated corpuscles of the liquid tissues to the complete and extended reticular structure described as existing in bone.

This theory naturally leads to some probable speculative views. If, as seems evident, the nerve-fibers originate in such extensions of the intercellular network, possibly the fibrils of individual cells have a conductive or nerve function, as also the contractile or muscle function which some writers ascribe to them. Their extension from cell to cell would indicate nerve communication, and it may be that the undoubted nerve and muscle function of many low animals, in which no nerves and muscles have been discovered, may be due to these interlacing fibrils. And the widely extended nerve-system of the higher

animals, by which the whole body is made one inter-related unit, may be but a final outgrowth of the fibrillar-cell system. The fibril reticulum of the isolated cell becomes the nerve reticulum of the complex body, which is virtually converted into a single cell, with its intricate network of fibers.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XLVIII.—THE WEAR AND TEAR OF THE BODY.

IN the course of these papers I have repeatedly spoken of the nitrogenous and non-nitrogenous constituents of food, assuming that the nitrogenous are the most nutritious, are the plastic or flesh-building materials; and that the non-nitrogenous materials can not build up flesh or bone or nervous matter, can only supply the material of fat, and by their combustion maintain the animal heat.

In doing so I have been treading on loose ground—I may say, on a scientific quicksand. When I first taught practical physiology to children in Edinburgh, many years ago, this part of the subject was much easier to teach than now. The simple and elegant theory of Liebig was then generally accepted, and appeared quite sound.

According to this, every muscular effort is performed at the expense of muscular tissue; every mental effort, at the expense of cerebral tissue; and so on with all the forces of life. This consumption or degradation of tissue demands continual supplies of food for its renewal, and, as all the working organs of the animal are composed of nitrogenous tissue, it is clearly necessary, according to this, that we should be supplied with nitrogenous food to renew them, seeing that the nitrogen of the air can not be assimilated by animals at all.

But, besides doing mechanical and mental work, the animal body is continually giving out heat, and its temperature must be maintained.

* Within the last few years research into the conditions of plant-cells has led to the interesting discovery that these cells are very generally connected by fine fibrils of protoplasm, in a manner somewhat similar to that which Heitzmann declares to be the general rule in animals. Possibly this may prove to be a universal condition. Mr. Walter Gardiner, in a memoir read before the Royal Society, April 26, 1883, says: "Although I am aware of the danger of rushing to conclusions, I can not but remark that when these results—which were foreshadowed by Sachs and Hanstein when they discovered the perforation of the sieve-plate—are taken in connection with those of Russow, it appears extremely probable that, not only in the parenchymatous cells of pulvini, in phlœm parenchyma, in endosperm-cells, and in the prosenchymatous bast-fibers, is continuity established from cell to cell, but that the phenomenon is of much wider if not of universal occurrence." This condition, so commonly present in plants, has as yet not been widely traced in animals, but may eventually prove to be equally general, as Heitzmann declares. The connecting protoplasmic fibril may be the embryo stage of the nerve-fiber, and may serve to bring every cell in the body within the range of nerve influence.

Food is also demanded for this, and the non-nitrogenous food is the most readily combustible, especially the hydrocarbons, or fats; the carbo-hydrates—starch, sugar, etc.—also, but in lower degree. These, then, were described as fuel-food, or heat-producers.

This view is strongly confirmed by a multitude of familiar facts. Men, horses, and other animals can not do continuous hard work without a supply of nitrogenous food; the harder the work the more they require, and the greater becomes their craving for it. On the other hand, when such food is eaten in large quantities by idle people, they become victims of inflammatory disease, or their health otherwise suffers, according, probably, to whether they assimilate or reject it.

Man is a cosmopolitan as well as an omnivorous animal, and the variation of his natural demand for food in different climates affords very direct support to Liebig's theory. Enormous quantities of hydrocarbon, in the form of fat, are consumed by the Esquimaux and by Europeans when they winter in the Arctic regions. They can not live there without it. In hot climates *some* fuel-food is required, and the milder form of carbo-hydrates is chosen, and found to be most suitable; rice, which is mainly composed of starch, is an example. Sugar, also. Offer an Esquimau a tallow-candle and a rice-pudding, he will reject the latter, and eat the former with great relish.

A multitude of other facts might be stated, all supporting Liebig's theory.

There is one that just occurs to me as I write, which I will state, as it appears to have been hitherto unnoticed. Some organs which act in such wise that we can *see* their mode of action are visibly disintegrated and consumed by their own activity, and may be seen to demand the perpetual renewal described by Liebig. There are certain glands of cellular structure which cast off their terminal cells containing the fluid they secrete; do their work by giving up their own structural substance at their peripheral working surface.

Where, then, is the quicksand? It is here. If muscular and mental work were done at the expense of the nitrogenous muscular and cerebral tissues, the quantity of nitrogen excreted should vary with the amount of work done. This was formerly stated to be the case without hesitation, as the following passage from Carpenter's "Manual of Physiology" (third edition, 1856, page 256) shows: "Every action of the nervous and muscular systems involves the death and decay of a certain amount of the living tissue—as is indicated by the appearance of the products of that decay in the excretions."

More recent experiments by Fick and Wislicenus, Parkes, Houghton, Ranke, Voit, Flint, and others, contradict this by showing that the waste nitrogen varies with the quantity of nitrogenous food that is eaten, but not with the muscular work done. For the details of these experiments I must refer the reader to standard *modern* physiological treatises, as a description of them would carry me too far away

from my immediate subject. (Dr. Pavy's "Treatise on Food" has an introductory chapter on "The Dynamic Relations of Food," in which this subject is clearly treated in sufficient detail for popular reading.)

It is quite the fashion now to rely upon these later experiments; but, for my own part, I am by no means satisfied with them—and for this reason, that the perspiration from the skin and the vapor from the lungs were not examined. It is just these which are greatly increased by exercise, and their quantity is very large, especially those from the skin, which are threefold, viz., the insensible perspiration, which is transpired by the skin as invisible vapor; the sweat, which is liquid; and the solid particles of exuded cuticle.

Lavoisier and Seguin long ago made very laborious experiments upon themselves in order to determine the amount of the insensible perspiration. Seguin inclosed himself in a bag of glazed taffeta, which was tied over him with no other opening than a hole corresponding to his mouth; the edges of this hole were glued to his lips with a mixture of turpentine and pitch. He carefully weighed himself and the bag before and after his inclosure therein. His own loss of weight being partly from the lungs and partly from the skin, the amount gained by the bag represented the quantity of the latter; the difference between this and the loss of his own weight gave the amount exhaled from the lungs.

He thus found that the largest quantity of *insensible* exhalation from the lungs and skin together amounted to three and a half ounces per hour, or five and a quarter pounds per day. The smallest quantity was one pound fourteen ounces, and the mean was three pounds eleven ounces. Three fourths of this was cutaneous.

These figures only show the quantity of insensible perspiration during repose. Valentin found that his hourly loss by cutaneous exhalation while sitting amounted to 32·8 grammes, or rather less than one and a quarter ounce. On taking exercise, with an empty stomach, in the sun, the hourly loss increased to 89·3 grammes, or nearly three times as much. After a meal followed by violent exercise, with the temperature of the air at 72° Fahr., it amounted to 132·7 grammes, or nearly four and a half times as much as during repose. A robust man, taking violent exercise in hot weather, may give off as much as five pounds in an hour.

The third excretion from the skin, the epithelial or superficial scales of the epidermis, is small in weight, but it is solid, and of similar composition to gelatine. It should be understood that this increases largely with exercise. The practice of sponging and "rubbing down" of athletes removes the excess; but I am not aware of any attempt that has been made to determine the quantity thus removed.

Does the skin excrete nitrogenous matter that may be, like urea, a product of the degradation or destruction of muscular tissue?

The following passage from Lehmann's "Physiological Chemistry," vol. ii, page 389, shows that the skin picks up plenty of nitrogen from somewhere: "It has been shown by the experiments of Milly, Jurine, Ingenhouss, Spallanzani, Abernethy, Barruel, and Collard di Martigny, that *gases*, and especially *carbonic acid* and *nitrogen*, are likewise exhaled with the liquid secretion of the sudoriparous glands. According to the last-named experimentalist, the ratio between these two gases is very variable; thus, in the gas developed after vegetable food, there is a preponderance of carbonic acid, and, after animal food, there is an excess of nitrogen. Abernethy found that on an average the collective gas contained rather more than two thirds of carbonic acid and rather less than one third of nitrogen." But it appears that less gas is exhaled when there is much liquid perspiration.

Lehmann's summary of the experiments of Abernethy, Brunner, and Valentin (vol. ii, page 391), gives the amount of hourly exudation, under ordinary circumstances, as 50·71 grammes of water, 0·25 of a gramme of carbon, and 0·92 of a gramme of nitrogen. This amounts to twenty-one and a half grammes of nitrogen per day in the *insensible* perspiration; three quarters of an ounce avoirdupois, or as much nitrogen as is contained in four and a half ounces of dried muscle, or more than one pound of natural living muscle.

That the liquid perspiration contains compounds of nitrogen, and just such compounds as would result from the degradation of nitrogenous tissue, is unquestionable. As Lehmann says (vol. ii, page 389), "the sweat very easily decomposes, and gives rise to the secondary formation of ammonia." Simon and Berzelius found salts of ammonia in the sweat; that the ammonia is combined both with hydrochloric acid and with organic acids; that it probably exists as carbonate of ammonia in alkaline sweat.

The existence of urea in sweat appears to be uncertain; some chemists assert its presence, others deny it. Favre and Schottin, for example, who have both studied the subject very carefully, are at direct variance. I suspect that both are right, as its presence or absence is variable, and appears to depend on the condition of the subject of the experiment.

Favre describes a special nitrogenous acid which he discovered in sweat, and names it *hydrotic* or *sudoric acid.* Its composition corresponds, according to his analysis, to the formula $C_{10}H_8NO_{13}$.

I have summarized these facts, as they show clearly enough that conclusions based on an examination of the quantity of nitrogen excreted by the kidneys alone (and such is the sole basis of the modern theories) are of little or no value in determining whether or not muscular work is accompanied with degradation of muscular tissue. The well-known fact that the total quantity of excretory work done by the skin increases with muscular work, while that from the kidneys rather diminishes, indicates in the plainest possible manner that an examina-

tion of the skin secretion should be primary in connection with this question.

Seeing that this has been entirely neglected, I am justified in expressing, very plainly and positively, my opinion of the worthlessness of all the modern research upon which the alleged refutation of Liebig's theory of the destruction and renewal of living tissue in the performance of vital work is based, and my rejection of the modern alternative hypothesis concerning the manner in which food supplies the material demanded for muscular and mental work.

I may be accused of rashness and presumption in thus standing almost, if not quite, alone in opposition to the overwhelming current of modern scientific progress. Such, however, is not the case. It is modern scientific *fashion*, rather than scientific *progress*, that I oppose. We have too much of this millinery spirit in the scientific world just now ; too much eagerness to run after "the last thing out," and assume, with undue readiness, that the "latest researches" are, of course, the best—especially where fashionable physicians are concerned.

XLIX.—THE MODERN THEORY OF FOOD.

In my last I summarized Liebig's theory of the source of vital power, and its supposed refutation by modern experiments, but had not space to state the substituted theory. I will now endeavor to do so, though not without difficulty, nor with satisfactory result, seeing that the recent theorists are vague and self-contradictory. All agree that vital power or liberated force is obtained at the expense of some kind of chemical action of a destructive or oxidizing character, and is, therefore, theoretically analogous to the source of power in a steam-engine ; but, when they come to the practical question of the demand for working fuel or food, they abandon this analogy.

Pavy says ("Treatise on Food and Dietetics," page 6) : "In the liberation of actual force, a complete analogy may be traced between the animal system and a steam-engine. Both are media for the conversion of latent into actual force. In the animal system, combustible material is supplied under the form of the various kinds of food, and oxygen is taken in for the process of respiration. From the chemical energy due to the combination of these, force is liberated in an active state ; and besides manifesting itself as heat, and in other ways peculiar to the animal system, is capable of performing mechanical work." In another place (page 59 of the same work), after describing Liebig's view, Dr. Pavy says : "The facts which have been already adduced (those described in my last paper) suffice to refute this doctrine. Indeed, it may be considered as abundantly proved that food does not require to become organized tissue before it can be rendered available for force-production." On page 81 he says : "While nitrogenous matter may be regarded as forming the essential basis of structures possessing active or living properties, *the non-nitrogenous princi-*

ples may be looked upon as supplying the source of power. The one may be spoken of as holding the position of the instrument of action, while the other supplies the motive power. Nitrogenous alimentary matter may, it is true, by oxidation, contribute to the generation of the moving force, but, as has been explained, in fulfilling this office there is evidence before us to show that it is split up into two distinct portions, one containing *the nitrogen which is eliminated as useless, and a residuary non-nitrogenous portion which is retained and utilized in force-production.*"

The italics are mine, for reasons presently to be explained. The following pages of Pavy's work contain repetitions and illustrations of this attribution of the origin of force to the non-nitrogenous elements of food.

Then we have a statement of the experiments of Joule on the mechanical equivalent of heat, connected with experiments of Frankland with the apparatus that is used for determining the calorific value of coal, etc., viz., a little tubular furnace charged with a mixture of the combustible to be tested, and chlorate of potash (better a mixture of chlorate and nitrate). This being placed in a tube, open below, and thrust under water, is fired, and gives out all its heat to the surrounding liquid, the rise of temperature of which measures the calorific value of the substance.

From this result is calculated the mechanical work obtainable from a given quantity of different food-materials. That from a gramme is given as follows:

Beef-fat	27,778	Units of work, or number of pounds lifted one foot.
Starch (arrow-root)	11,983	
Lump-sugar	10,254	
Grape-sugar	10,038	

In Dr. Edward Smith's treatise on "Food," the foot-pound equivalent of each kind of food is specifically stated in such a manner as to lead the student to conclude that this represents its actual working efficiency *as food.* Other modern writers represent it in like manner.

Here, then, comes the bearing of these theories on my subject. A practical dietary or *menu* is demanded, say, for navvies or for athletes in full work; another for sedentary people doing little work of any kind.

According to the new theory, the best possible food for the first class is fat, butter being superior to lean beef in the proportion of 14,421 to 2,829 (Smith), beef-fat having nearly eight times the value of lean beef. Ten grains of rice give 7,454 foot-pounds of working power, while the same quantity of lean beef only 2,829; according to which one pound of rice should supply as much support to hard workers as two and one half pounds of beefsteak. None of the modern theorists dare to be consistent when dealing with such direct practical applications.

I might quote a multitude of other palpable inconsistencies of the theory, which is so slippery that it can not be firmly grasped. Thus, Dr. Pavy (page 403), immediately after describing bacon-fat as "the most efficient kind of force-producing material," and stating that "the *non-nitrogenous* alimentary principles appear to possess a higher dietetic value than the *nitrogenous*," tells us that "the performance of work may be looked upon as necessitating a proportionate supply of *nitrogenous* alimentary matter," his reason for this admission being that such nitrogenous material is required for the nutrition of the muscles themselves.

A pretty tissue of inconsistencies is thus supplied! Non-nitrogenous food is the best force-producer—it corresponds to the fuel of the steam-engine; the nitrogenous is necessary only to repair the machine. Nevertheless, when force-production is specially demanded, the food required is not the force-producer, but the special builder of muscles, the which muscles are not used up and renewed in doing the work.

It must be remembered that the whole of this modern theoretical fabric is built upon the experiments which are supposed to show that there is no more elimination of nitrogenous matter during hard work than during rest. Yet we are told that "the performance of work may be looked upon as necessitating a proportionate supply of nitrogenous alimentary matter," and that such material "is split up into two distinct portions, one containing the nitrogen, which is eliminated as useless." This thesis is proved by experiments showing (as asserted) that such elimination is not so proportioned.

In short, the modern theory presents us with the following pretty paradox: The consumption of nitrogenous food is proportionate to work done. The elimination of nitrogen is *not* proportionate to work done. The elimination of nitrogen is proportionate to the consumption of nitrogenous food.

I have tried hard to obtain a rational physiological view of the modern theory. When its advocates compare our food to the fuel of an engine, and maintain that its combustion *directly* supplies the moving power, what do they mean?

They can not suppose that the food is thus oxidized as food; yet such is implied. The work can not be done in the stomach, nor in the intestinal canal, nor in the mesenteric glands or their outlet, the thoracic duct. After leaving this, the food becomes organized living material, the blood being such. The question, therefore, as between the new theory and that of Liebig must be whether work is effected by *the combustion of the blood itself*, or the degradation of the working tissues, which are fed and renewed by the blood. Although this is so obviously the true physiological question, I have not found it thus stated.

Such being the case, the supposed analogy to the steam-engine breaks down altogether; in either case, the food is assimilated, is con-

verted into the living material of the animal itself before it does any work, and therefore it must be the wear and tear of the machine itself which supplies the working-power. and not that of the food as mere fuel-material shoveled directly into the animal furnace.

I therefore agree with Playfair, who says that the modern theory involves a "false analogy of the animal body to a steam-engine," and that "incessant transformation of the acting parts of the animal machine forms the condition for its action, while in the case of the steam-engine it is the transformation of fuel external to the machine which causes it to move." Pavy says that "Dr. Playfair, in these utterances, must be regarded as writing behind the time." He may be behind as regards the fashion, but I think he is in advance as regards the truth.

My readers, therefore, need not be ashamed of clinging to the old-fashioned belief that their own bodies are alive throughout, and perform all the operations of working, feeling, thinking, etc., by virtue of their own inherent, self-contained vitality, and that in doing this they consume their own substance, which has to be perpetually replaced by new material, the quality of which depends upon the manner of working, and the matter and manner of replacement. We may thus, according to our own daily conduct, be building up a better body and a better mind, or one that shall be worse than the fair promise of the original germ. The course of our own evolution depends upon ourselves, and primarily upon the knowledge of our own physical and moral constitution, and their relations to the external world. Of such knowledge even the humble element supplied by "The Chemistry of Cookery" is one that can not be safely neglected.—*Knowledge.*

INTERNAL ARRANGEMENT OF TOWN-HOUSES.

By ROBERT W. EDIS, F. S. A.

GOOD planning means not merely the arrangement of a certain number of rooms on a certain number of floors, but careful and close attention to the general domestic requirements and arrangements of the ordinary householder, and to all smaller details which make up the comfort and convenience of the house. It means that every foot of space shall be properly laid out, that there shall be no dark corners, and no inaccessible places, and that every room, closet, and staircase shall have ample light and ventilation, and that staircases shall be conveniently arranged, easy, with broad landings, and of sufficient width to allow of passing conveniently.

Each room has to be considered, and its relative proportion and position in the plan. The dining-room, or general eating-room of a house, should be so arranged that, although above the kitchen-level,

it shall not be at any unreasonable distance, whereby an extra amount of carriage of dishes and service is required.

If it be possible in an ordinary town-house of the first or second class, the dining-room should be placed at the back, as it is rarely used except at meal-times, and good outlook is not necessary; besides which, in summer-time, when it is pleasant to have windows open, if the room face a much-used thoroughfare, there is all the unpleasantness of noise of traffic and constant in-rush of dust; whereas, if placed at the back, provided always the light-area into which the room looks be of sufficient size, and lined with glazed bricks, with some slight variation in colored lines or panels, with window-boxes filled with sweet-smelling flowers or shrubs, there is freedom from noise and dust, and the comfort and quiet of the room are considerably enhanced.

Next the dining-room should, if possible, in every house, be arranged a small service-room, with a light service-lift from the basement, by which a considerable saving of labor will be gained, better service, and if, in this room, a small hot plate be fitted up, heated by gas, the plates can be brought in hot instead of half cold, as is so frequently the case. This lift should be taken down in the basement to a small china closet or pantry, close to the kitchen, but quite separate, so that it may not be made a funnel or shaft up which the smell of the kitchen can ascend. If, however, the kitchen be really properly ventilated, with plenty of fresh air inlets and extract-shaft over the fireplace—that is, immediately over the cooking portion of the kitchen—there should be no risk of smell, even if a serving-hatch is made direct into the kitchen; but it is better, if possible, to separate the two by a small lobby. If this special service-room can not be provided, a small lift may easily be arranged in the buffet, or at one end of the dining-room, and this need be only of the lightest description, so as to be easily workable by a maid-servant. To the lift, a speaking-tube or electric bell, or both, should be attached, and these will not only be found convenient at meal-times, but, in sudden emergencies, when unbidden and unexpected guests arrive and stay to dinner or luncheon, will give an easy means of communication between the mistress and the cook. It is well to get a service-room on the ground-floor, next to the dining-room, if possible, as this can be fitted up with sink and cupboards, all useful for washing up and storing away glass and china, and thus avoiding the risk of carrying up and down stairs. Naturally, the servant, man or woman, is anxious to save him or herself as many journeys from the basement as possible, and thus frequently he or she is inclined to overcrowd the trays, to the imminent risk of everything on them.

As a rule, a dining-room must have a central light over the table, but this should not be of such a size as to impede the view from either end, or to cause an amount of heat on the heads of those who are sitting round it. A small light, with a shade made to throw its rays

direct upon the table, with—if gas be used—side-brackets next the sideboard, and on either side of the mantel-piece, so as to distribute the light all over the room, and light up the pictures or whatever else is upon the walls, is infinitely better than a great blaze over the table, neither pleasant nor comfortable to those who have to face its glare, and ofttimes unpleasant heat. To avoid all this, it is essential that pure fresh air shall be introduced and distributed over the room, to take the place of that which necessarily becomes foul and tainted by fumes of cooked meats, gas, and the straining of the cubical contents of air-supply by a larger number than usual of people using the room. If there be no means of providing fresh air, and no means of extracting foul air, it follows that, in a very short time, the good air originally contained in the room will become tainted, and at last heated and foul.

Stand on a chair in an ordinary London room, about an hour after it has been lit up and the dinner commenced, and you will then obtain for yourselves some practical knowledge of the suffocating nature of the upper stratum of air, and will not wonder that faintness, nausea, and headache, are often necessary portions of a dinner-party in an improperly ventilated room.

All this can be cured by providing in, say, each corner a tube, adjusted in proportion to the size and height of the room, for the access of fresh air through gratings from the outside wall ; and the current and amount of air injected, so to speak, into the room, can be easily adjusted by an ordinary butterfly valve, and all dust and soot, and other impurities kept back by a piece of fine silk or wet sponge. These tubes are often put in much too small, and the size of the outside grating is not considered ; in all cases the size of the tube should be proportioned to the cubical contents of the rooms, and the external grating should be, practically, twice the area of that of the tube, as the iron-work of the grating, as a rule, diminishes its usefulness in ventilating area by about half.

If it be not possible to arrange for an extract shaft in the ceiling, a large-sized ventilator may be put in the flue over the fireplace, provided always it be fitted with talc flaps to prevent all back draught ; but even the introduction of fresh air alone by some such means as those I have named will make a difference in a few minutes of many degrees in the temperature of the room.

In ordinary houses nothing has struck me as so wanting in thought as the general arrangement of the staircase. As a rule, you enter from the front door into a narrow passage-way, with perhaps an internal screen, with folding-doors which are rarely shut, and immediately opposite is the main staircase of the house, so that any one, on entering, not only commands the absolute thoroughfare of the house, but sees everybody who goes up or comes down, by which privacy is materially interfered with, and the whole house is made subject to sud-

den draughts of cold air, which are driven up the well-hole, as it is called, by the opening of the street-door.

There is no reason why the ordinary narrow entrance should not be increased two or three feet, so as to make a moderate-sized hall, in which you may have a fireplace, which will help to supply warm, fresh air all over the house, and, by a little care in planning, the first flight of stairs at least may be screened from view.

There are now very many good ventilating grates which can be so arranged as to provide, with communication from the outside, warmed fresh air, and if one of these, of sufficient size, be placed in the hall, it will not only help to ventilate it, and to lessen the evils of heated and foul air generated by the gaslight, but can be made the means of introducing warmed fresh air all over the house.

The staircase itself, whether it be of wood or stone, should never rise more than six and a half inches to each step, and, if possible, a landing or resting-place should be arranged every twelve or fifteen steps. In ordinary London houses the half-landing is sufficient, but all winders are fatal to a good staircase.

In the hall it is essential to have proper ventilation ; if you shut the screen or inner hall doors, as a rule, the air becomes contaminated and heated by the gaslights, and the staircase and passages are fed with foul instead of fresh air. It is essential, therefore, that a proper supply of fresh air should be brought in independent of the door, and this can be done by means of a proper ventilating grate, or, if there is no fireplace, by a simple ventilating letter-box, or by some such arrangement as that which I have suggested for the dining-room ; in fact, in every room throughout the house fresh air should be brought in, either warmed over hot-water coils, or direct through tubes communicating with the outside, or through some of the best of the now numerous ventilating grates, which are made so as to feed the house and counteract the evils caused by overcrowding, or by the products of combustion of gas or oil-lamps.

The library may be arranged as a comfortable and quiet apartment at the back, while the front space may be devoted to the morning or general reception-room, in which all the cheerfulness which the outlook into a London street allows can be obtained ; but do not sacrifice the entrance and hall entirely to these rooms. Give an extra foot or two to the passage-way of the house, and you will not only make it more imposing and important, but will add materially to its comfort and convenience when you receive guests, and to its healthiness by providing a larger shaft for air circulation.

The basements of London houses are generally so badly arranged and ventilated that they add materially to their stuffiness ; for, as a matter of course, all foul air is apt to fly upward, and if the basement be foul, heated, and unhealthy, it forms the practical reservoir from which the whole house derives a large amount of its general

temperature and tone, and too much care can not, therefore, be taken in its proper sanitary arrangement. Above all, in new houses it is important that the whole surface of the ground shall be covered with concrete, and that proper damp courses shall be inserted in the walls to keep down all damp, with air-bricks for ventilation under all wood floors. The basements should be, in every sense, dry and sweet, and all passage-floors made absolutely damp-proof, and the latter can best be done by putting down Portland cement concrete six or eight inches thick, finished off to a fair surface so as to form an even floor, and not, as is so often done, with a thin layer or covering of finer cement over the concrete bed, which, by-and-by, is sure to peel off and leave a rugged and uneven surface.

The scullery should, as a rule, form part of the kitchen, where the kitchen is not used for servants' meals and sitting-room, and not be shut off, or, if so, only by a low glass screen. It is merely a washing-up place, and should be under the immediate supervision of the cook, and not, as is so often the case, a small, dark, unpleasant, and ill-ventilated hole, in which bad smells are supposed to be allowed. It should be as fresh and as sweet as any other portion of the basement.

Line the whole of the scullery walls and, as far as possible, those of the kitchen also, with glazed tiles, so that there be no absorption and retention of the smells which must necessarily accrue with the ordinary work of this portion of the house ; bring in fresh air, provide means for extraction of foul, but do not make a pestilential corner.

I can not too strongly advocate the finishing of all the walls in a basement, so far as the working portion of it, and the passages, are concerned, with glazed tiles ; they are cleanly, absolutely non-absorbent, reflect and give light, are easily washed, and tend to make the house sweet and healthy. The pantries and larders should be so arranged that they have continued ingress of fresh air, and should in all cases be lined with glazed tiles or bricks, so that the emanations from the contents should not be absorbed in distempered walls.

They can easily be made fresh by bringing in outside air, by means of external gratings and tubes, and everything should be done to provide a constant draught and sweeping out of the foul air which is naturally engendered by hanging game and uncooked meat. The shelves should be of slate, or, better still, of polished marble, so as to be absolutely non-absorbent and easily cleaned.

As in all town-houses, where space is limited, a large portion of the rear offices derive their light and air from the small inclosed areas at the back, it is of the utmost importance that these areas should be lined with glazed bricks, to keep them as light and as sweet as possible, and, as the air at the bottom is likely to become stagnant and vitiated, a direct current should be insured up all these small light-areas, by means of a large induct shaft built under the basement floor

from the front area, so as to provide for constant circulation and change of air; this can be done at a very trifling cost, as the shaft may be formed of, say, glazed drain-pipes eighteen inches diameter, covered at each end with large open gratings made to lift up, so that the shaft may occasionally be cleared out.

In every basement a comfortable room for servants should be provided; some small sitting-room, fitted up with book-shelves and cupboards, and if possible facing the street, so that the workers of the house may have some sort of spare room in which they may be at rest from their ordinary duties; for if you want good servants you must treat them as ordinary beings like yourselves; and it is hardly fair to leave them for all hours in the heated and not always pleasant atmosphere of the working-rooms.

I can not too strongly insist upon the necessity of making those about us as comfortable as possible; for I am quite sure that, if we provide comfort and health for them, they will be much more capable of doing their daily work fairly and acting well by us. Remember always that a large proportion of their lives is spent absolutely underground, and that it is essential that they should have at least one room which shall be cheerful, well ventilated, and as pleasant as we can make it. Put yourselves in their places, and do as you would be done by, and, so far as my experience teaches me, I am morally certain that the master or mistress who provides well-lighted apartments for them to live and sleep in, will be more certain of keeping good servants, and of obtaining good work from them; if they are to be mewed up in ill-ventilated, uncomfortable, and unhealthy chambers for the greater part of their daily lives, you can hardly expect their work to be properly done; the atmosphere in which they live will enervate them, and make them comparatively useless.

The kitchen department should, as far as is consistent with proper and quick service, be shut off from the staircase of the basement, as this naturally acts as a funnel up which all smells ascend, so that, when the door at the top, which opens into the hall, is open, they escape and permeate the whole house; a swing-door can generally be arranged at the bottom of these stairs, provided with one of those patent American valve springs which close the door at once without allowing it to bang.

In every house, if possible, a small coal and luggage lift should be provided; in a new house, where there is a back staircase, it may run up in the well-hole; and in any old house it may often be arranged outside the back wall, with openings on to the various staircase landings.

If attention be paid to these smaller details in house-planning, I believe that in many cases the cost of a servant may be saved, for every one knows the daily labor in winter-time of carrying up heavy scuttles of coals and wood, and the great addition to the work of the

house by having constant journeys from the basement to the second and third floors.

Too much care can not possibly be taken in providing the necessary conveniences in the way of store-closets near to the kitchen, so as to reduce to a minimum the service and labor expenditure in the house; and in every case proper ventilation is easily obtainable by a little forethought on the part of the architect or builder, so that each closet and cupboard may be kept sweet and airy; there should be no dark corners in which dust and filth may be allowed to accumulate, but ample light and ventilation everywhere. It is easy to provide for a large fresh-air drain or channel from back to front, such as I have named, in every new house, out of which separate ducts may be taken to every cupboard or closet; and this main air shaft or duct should be continued into the back area, or lighting space for the back rooms, so that a constant draught shall be caused, and the air not allowed for a moment to stagnate.

The back areas are often of necessity made small, and if unprovided by some arrangement such as I have described, by which a constant change of air is enforced, the lower portion becomes absolutely foul and unwholesome, and any air drawn from it for ventilation is practically worse than useless.

In Professor Kerr's book on the planning of country-houses, he lays great stress on comfort as an essential element. Now, this means good constructive care in the arrangement of the different portions of the house; all proper and requisite conveniences, light, warmth, and good ventilation everywhere; freedom from damp and smells, no smoky chimneys, and no badly-constructed floors, through which noise from above or below may be readily heard. If these essentials are not properly looked after, the finest design, the most useful decoration, the most graceful art, all go for nothing, for common-sense people are apt to appreciate the mere material comfort and convenience of the house much more than the art-work in the external elevation, or in the internal decoration of their rooms.

I do not propose to enter upon the question of drains or sewage ventilation, as this subject has been treated by many more able lecturers than myself in these rooms, who have made it their special study, and I would only propose very briefly to refer to it. I can only insist upon every closet being thoroughly ventilated, upon all sink-wastes being cut off from the main sewer, and upon all drains which must perforce be carried through the house being laid and bedded in concrete, with man-holes at each end, to sweep them clean from end to end if necessary, for proper traps cutting off all drains directly from the main sewer; that all sink-wastes empty clear over proper traps, and to avoid everywhere any connection with the main drains, whereby sewer-gas can in any way be brought into the house.

All closets and bath-rooms should, if possible, be lined with tiles or

some equally non-absorbent material, for, unless this done, they soon become stuffy and unpleasant.

The drawing-rooms of the house should naturally be made as cheerful as possible, and doors arranged so as to allow for the proper circulation of your guests when the rooms are crowded.

The arrangement of windows and fireplaces should be carefully studied, so as to allow of sufficient wall-space for furniture, and in these rooms bay and recessed windows and cozy nooks will help to make them more liveable and comfortable, whether for the ordinary occupants, or on occasions when you receive your friends.

As a rule, I think two fireplaces are a mistake, unless the rooms be absolutely divided by doors or *portières*, as, when only one fire is alight, there is a tendency for it to act as a pump, and to draw down smoke through the other.

If the room be very long, a small coil of pipes, taken off the hot-water service, may generally be arranged under the back window, over which fresh air may enter for ventilation.

Street houses are more or less, by the limited nature of the ground on which they stand, bound to be very similar in plan ; but they can all be materially improved by a careful study of the wants and requirements of the ordinary householder, and by a proper regard and attention to all the smaller conveniences which practically render the house comfortable or the reverse.

As a general rule, bedrooms are often very badly arranged ; either the wall-space is planned so that the bed must be placed immediately opposite the light, or in a thorough draught between the door and fireplace. I am inclined to think that the modern system of arrangement in French bedrooms might with advantage be more frequently carried out in town-houses, and that the rooms might be made suitable for the double purpose of private sitting as well as bedrooms. In a house in which there are several grown-up sons and daughters, it will be evident that some such arrangement will commend itself, so that each may have a private working-room, for writing or studying, apart from the general living-rooms of the house. The bedroom may often, therefore, be divided up so as to form at one end—that farthest from the window—recesses for bed and washing-closet, which can be screened off in the daytime by a curtain, and the rest of the room fitted up as a sitting-room, wherein the occupant may receive his or her own more intimate friends if need be.

The dressing-rooms are often made much too small. They should be of sufficient size to hold a bed if requisite, so that it may be used on occasions when, let us say, the master of the house comes home late, and does not want to disturb the wife of his bosom in the small hours of the morning ; or when sickness is in the house, the room can be used for a nurse ; or if the master of the house be a professional man, afflicted occasionally with sleeplessness, he would often like to

take up his work, instead of tossing about for hours, or lying restless, and tortured with all the troubles which seemingly come in upon him on such occasions.

The nurseries of a house should be cheerful, well lighted, and well ventilated, and made to open into each other, so that at night-time the door may be left open, and the air space made as large as possible. A small pantry or scullery should be fitted up on the same floor, with sink and ample closets or cupboards for crockery and toys, and, if possible, a water-closet and bath-room close adjoining.

The servants' rooms should be made as healthy and convenient as any other rooms in the house, well lighted, and, being in part in the roof, care should be taken in all new houses to protect them from undue heat and cold by means of boarding and slates, by overlaying the former with battens, on which the slates are hung, so that, as far as practicable, the rooms may not be rendered hot and close in summer, or icy cold in winter. All these precautions can easily be taken in the building of a new house without any great additional cost, and will amply repay the extra outlay by the increased comfort and healthiness of the house.

Somewhere on the top floor a lumber-room should be provided, lighted from the roof, and this should be boarded all round, so as to prevent the damage which is often caused in plastered rooms by the boxes being placed roughly against the walls. A cistern-room is also essential in every well-found house, boarded in to keep it clean and free from dust and filth, which would be sure to foul the water; top-lighted, so as to enable the cisterns to be examined and frequently cleaned out, and from this room access might be had to the outside of the roof.

As far as practicable, all water-pipes, hot and cold, should be run up together, properly labeled and easy to be got at, in a chase or recess which should be cased over and closed with screws. The hot-water pipes, if properly felted in, would contain a sufficient amount of heat, long after the kitchen fire is out, to keep the space, even if next to an outside wall, well above freezing-point.

The bell-wires should all be laid in zinc tubing, the gas-pipes always iron, and not what is called composition, and in no case should any pipe of any kind be rendered inaccessible by being buried in some remote corner, or in the plaster-work of the rooms. The ordinary plumber and gas-fitter takes no heed of how his pipes go, and what happens to them after he has fixed them in their places; his anxiety seems to be to carry them by the shortest possible way to the points at which they are to be used, and, unless carefully looked after, you may be tolerably certain that they will be so hidden away that, in case of accident, you will have to pull up half the floors of your house, or knock about a good many of your walls, to discover any leakage, especially if it be in a gas-pipe.

Fire risk rarely enters the head of any builder, and he is content to leave the upper floors to be cut off by the burning of the wooden attic stairs, and allow the occupants to be slowly grilled or suffocated, that is, so far as any means of escape shall have been provided by him. In all high street houses ready access should be made at various points in the attic story to the roof, and iron ladders fixed against the party walls, so as to enable the occupants to get readily away. This has its objections, of course, as enabling thieves to pass from an empty house to any of those in the same block; but good trap-doors, well bolted and lined with iron, would practically keep them out, or at least they would make noise enough in their attempt to open them to make themselves heard when the house was occupied by the family.

Speaking-tubes should be put up in every house, or at all events one communicating on every floor, for it is quite easy to establish a simple code of signals by which one whistle calls the down-stairs servants, and two for those on the nursery-floors. In this manner the constant running up and down stairs to answer bells, and then to bring what is wanted perhaps up many flights of stairs, is avoided.

As Emerson says truly, in one of his essays: "Take off all the roofs from street to street, and we shall seldom find the temple of any higher god than prudence. The progress of domestic living has been in cleanliness, in ventilation, in health, in decorum, in countless means and acts of comfort, in the concentration of all the utilities of every clime in each house. . . . The houses of the rich are confectioners' shops, where we get sweetmeats and wine; the houses of the poor are imitations of these to the extent of their ability." Avoid all such imitations; let our houses be fitted for every-day wants, for every-day requirements; let them above all be clean, be comfortable, be healthy; let there be no unfound skeletons, no tangles that are not unraveled; open up the doors, let light and air in upon the skeletons, search them out; make the houses you live in pure from end to end, and depend upon it you will have less disease of mind or body, less worry, less enervation, unless you agree with the Scriptural statement that "Ahithophel set his house in order and hanged himself." One would have expected him to hang himself because his house was not set in order.

Remember always that the healthiness, the comfort, and the pleasant and artistic arrangement of your houses mean the healthiness, the education, and the bodily and mental soundness of your children.—*From a Lecture before the Society of Arts.*

SKETCH OF PROFESSOR JOHN TROWBRIDGE.

PROFESSOR TROWBRIDGE is the son of a physician, and was born in Boston in 1843. He prepared for Harvard University at the Boston Latin School, but did not join the Freshman class. He entered the Lawrence Scientific School, from which he was graduated in 1866. He was tutor in the Scientific School for the two years succeeding his graduation, and was appointed Assistant Professor of Physics in the Massachusetts Institute of Technology in 1868. In 1870 he was called to Harvard University as Assistant Professor of Physics to establish a laboratory course of instruction. He obtained the degree of Doctor of Science from Harvard in 1873. For the past six years he has been Professor of Experimental Physics in the university.

The descent and early education of scientific men have lately become the subject of investigation by Galton. None of the ancestors of Professor Trowbridge evinced any scientific tastes, although there were several who had strong literary tastes and also legal ability. Professor Trowbridge's father, believing in the adage of Bacon, that a boy, if given the range of a library, will select the food most suitable to his tastes, provided him liberally with books, but not with instructors; and, being fond of art himself, stimulated a certain fondness for drawing in the child. The consequence of this training was that, when the boy at the age of fourteen or fifteen entered the public schools, he had a large amount of desultory information in literature and a facility for drawing, but no systematic training in languages or in mathematics. While, however, many of his comrades who had been carefully trained in schools from an early age grew tired of intellectual effort, he came to the subjects of mathematics and the sciences with a certain freshness which might not have survived too much school-culture at an early age. His strong taste for art made his friends predict an artistic career as the only one suitable for him. His graduation at the Lawrence Scientific School with the degree of *Summa cum Laude*, and the evidence of strong mathematical tastes, determined his future career.

When Professor Trowbridge came to the university in 1870 as a teacher, the subject of physics was taught merely by lectures and recitations. He immediately secured a small room and fitted it up as a physical laboratory. From this small beginning arose, through his constant endeavor, the Jefferson Physical Laboratory, which is the largest laboratory of the kind at present in America. In order to secure this great means for advancing the study of physical science in the university, Professor Trowbridge has given his best efforts for the past ten years in the direction of personal solicitation, and by publishing in

various journals, and also in pamphlet form, papers upon the necessity of an adequate recognition of the importance of a well-equipped physical laboratory at Harvard University.

He was editor for two years of the "Annual of Scientific Discovery," published by Gould & Lincoln, of Boston—a publication which was a pioneer in the effort to make the results of science available to the general reader.

The first scientific paper of Professor Trowbridge was upon a new form of galvanometer, which he entitled the "Cosine Galvanometer." Before the invention of this instrument the tangent galvanometer and the sine galvanometer were the only forms of galvanometer known in scientific literature. The cosine galvanometer, which made use of the principle of a vertical coil, movable about a horizontal axis, gave an additional adaptation, and affords a convenient method of measuring strong electrical currents. His next paper was upon animal electricity. The result of long investigation had deepened in him the conviction that the observations of Du Bois-Reymond had not established the existence of so-called muscular electrical currents. The operation of detaching a muscle from its position and examining its electrical condition by means of a galvanometer must result in experimental errors which have hitherto masked any electrical currents due to the generation of electricity in the muscle itself. It is true that the torpedo and few electrical fishes can generate electricity; but in these animals certain organs for the generation of this electricity have been discovered, and this is not true of the ordinary muscle. The effects observed are due to the contact of the so-called non-polarizable electrodes with fresh muscular tissue; in other words, to the fact that the so-called muscular electrical currents had their seat in the contact between the electrodes and the fluids of the fresh muscle. These results, being in opposition to the belief of the leading German physiologists, were not accepted. Since the publication of Professor Trowbridge's paper, however, prominent German physiologists have taken the same view. He was one of the first to measure the relative efficiency of various forms of dynamo-electric machines. His experiments were conducted at the United States Torpedo-Station at Newport, Rhode Island. For this purpose he invented a new form of electrical dynamometer, which enabled one to measure the strongest electrical current without subdividing it.

In the course of this investigation, being struck with the large amount of heat developed by the reversals of magnetism in the core of an electro-magnet, he undertook a separate investigation together with the chemist of the Torpedo-Station, Mr. Walter N. Hill, upon the amount of this heating, in a great variety of steels of different composition, in the hope of arriving at a practical method of testing the composition of steel. The results of the investigation tend to strengthen the general belief that the heat due to the reversal of mag-

netism must be attributed to induced currents in the iron or steel, rather than to reversals of magnetism in molecular magnets. A later investigation upon the same subject tends to confirm the above result.

Among the instruments invented by Professor Trowbridge may be mentioned a new form of induction-coil, in which the primary coils are employed, and two induction-coils, the poles of the electro-magnets being connected by thin plates of iron. The spark produced from this combination by a mechanical break has great heating effect.

The active duties of a college professor leave little time for continued systematic investigation. A new era, however, is dawning in university education in America, and the college professor who shows ability for scientific investigation will undoubtedly be relieved of the yearly teaching of immature minds and be left free to devote himself to graduate students, to research, and to the general supervision of his department, rather than to the daily drill which should be left to trained assistants. Notwithstanding his full duties as a professor, Professor Trowbridge has published each year various investigations from the Physical Laboratory of Harvard University, which up to the present time has consisted of merely one room, inadequately fitted up for scientific work. In these investigations he has been often assisted by students. Among his researches are papers on the conveyance of heat by the electrical current in various metals, particularly in nickel ; a paper written in association with Mr. C. B. Penrose, on the availability of a thermal junction for measuring very low temperatures ; on the formation of vortex-rings in liquids, and an interpretation of the mathematical formulæ relating to vortex-rings in water ; a paper by himself and Mr. Penrose, on the propagation of heat at right angles to, and in the direction of, the lines of magnetic force ; a study of the effect of displacement of the compass in the Helmholtz's form of Gaugain galvanometer ; a paper on the cause of the disturbances heard on telephone-lines, in which it was shown that a large part of their disturbances is due to the battery—earth. A survey of the country about Cambridge showed that the time-signals of the Harvard College Observatory were transmitted through the earth over a great extent of territory. This survey suggested to Professor Trowbridge the possibility of telegraphing across large bodies of water without a wire. Mr. Preece, of the London telegraphic system, acting upon the suggestion of Professor Trowbridge, succeeded in transmitting telegraphic signals from Southampton to the Isle of Wight, without a wire. Professor Trowbridge has also published various papers on thermo-electricity, a subject which has occupied his thoughts for many years.

The condition of the teaching of physics in the secondary schools having been brought to his attention by the want of preparation in this subject of students who present themselves for entrance to the university, Professor Trowbridge has prepared a treatise on experi-

mental physics, entitled "The New Physics," in which modern views of the great subject of physics are inculcated through the means of elementary laboratory work. He has also contributed various essays to the "Atlantic Monthly," one of which, entitled "The Dream of Life," is an argument, *ad hominem*, in favor of the option of scientific studies by students who desire to enter the university without Greek. His contributions to "The Popular Science Monthly" treat of various subjects, among which may be mentioned: "Science from the Pulpit"; "On the Teaching of Physics in the Secondary Schools"; "On the Use of Electric Lights for Steamships." In the latter paper, Professor Trowbridge advocated the use of the electric light for a head-light. Practical navigators, however, assert that such light is not to be recommended, for its dazzling glare confuses the eyes of the steersmen of approaching vessels.

His address before the American Association for the Advancement of Science was upon the question, "What is Electricity?" and, in reading it, one can discover the directions in which the author has investigated.* The life of an investigator is an arduous one; but few of the ideas which take months to investigate give what are called positive results. Faraday, it is true, gave to the world the history of both his successful experiments and his unsuccessful ones. It is not the custom, however, of later physicists to do this. Scientific literature is already voluminous, and this reticence of scientific men is perhaps a boon to those who desire to look up any subject. With the increased facilities which the new laboratory at Cambridge will give, Professor Trowbridge enters upon a fresh scientific career in the prime of life, and there is reason to hope that many positive results to science will accrue from his future labors.

He is a member of the American Academy of Arts and Sciences, of which he was secretary from 1879 to 1884; he is also a member of the National Academy of Sciences. He is one of the editors of the "American Journal of Science." He was a member of the International Congress of Electricians which met in Paris, in 1883, and of the United States Congress of Electricians which met in Philadelphia last October. He was also one of the Vice-Presidents of the American Association for the Advancement of Science for 1884, at the Philadelphia meeting.

* See "The Popular Science Monthly" for November, 1884.

CORRESPONDENCE.

CAUSES OF THE OHIO FLOODS.

Messrs. Editors:

IN the November issue of your valuable "Monthly" I have read with much pleasure and profit Mr. S. W. Powell's article entitled "Drowning the Torrent in Vegetation"; and, in closing, he writes, "In the recent Ohio floods the States which suffered most—Ohio, Indiana, and Illinois—were not those where most of the deforesting was done which caused the floods."

While I heartily agree with him that the removal of our forests adds largely to the destructiveness of the floods, yet I do not agree with him that to that cause can be attributed the greater portion of their destructiveness, and especially in Western Pennsylvania and Ohio, where the larger portion of the water came from that did the damage in Cincinnati and the Ohio Valley above.

My theory is, that the increasing destructiveness of the floods in the Ohio and Mississippi Valleys is mainly due to the rapid increase of tile-drainage throughout Pennsylvania and Ohio, and in small portions of West Virginia, and the entire country drained by the Ohio and Mississippi Rivers and their tributaries.

The facts are, that the increase of destructiveness of the floods in the Ohio Valley has been in a ratio corresponding with the increase of tile-drainage—as near as the statistics obtainable concerning the latter will show.

It is not the writer's purpose to discuss the matter at any length in this letter, but merely to call the attention of the reader to its probable truth or falsity.

It is a well-known fact that a goodly portion of the land lying between the Alleghany Mountains and a line drawn north and south through Dakota, Kansas, and Nebraska, and bounded on the south by West Virginia, Kentucky, and Arkansas, is more or less of a swampy nature, retaining the water as it falls—somewhat as a sponge would—and has, until very recently, been left in its natural state.

The rapid increase of population of the country has caused an increased demand for land, and, taken in connection with the improved machinery for making tile having reduced the price of tile to a mere nominal figure, has caused farmers to improve their damp and swamp lands, as well as much uplying land, by tile-drainage.

The effect of this has been to cause the water from melting snow and rain-storms to immediately discharge itself into the water-courses; whereas formerly from these swampy lands it ran off very slowly, and the same volume of water, that with tile-drains is discharged now in twenty-four to forty-eight hours, originally took from seventy-two to one hundred and twenty hours to discharge.

The best statistics obtainable show that tile-drainage has doubled since 1878, and will undoubtedly continue to increase very rapidly, because it has been found to prove advantageous to all lands, and I am informed that there is one farmer in this State who has, during the year 1884, laid upward of eleven miles of tile-drains upon his farms.

The writer predicts that but few years will pass before several of the lower streets of Cincinnati will be abandoned to the flood, and that many towns along the valleys will also be partially swept away and not rebuilt.

The only things which will prevent this will be slight rainfalls and very gradual thawing of the snow, whenever the latter falls to an extent to produce an amount of water that will cause a flood.

Farmers will not stop laying tile, because they have found it to be a paying investment, rendering swamp-lands tillable, and increasing the yield and sureness of crops upon the upland, as well as rendering it much more easy of cultivation. Consequently, it looks to us as though the dwellers in the "bottoms" must go.

Yours truly, JAMES F. SLATER.

HIGHLAND PARK, ILLINOIS, *November* 22, 1884.

DO ANIMALS FORETELL THE WEATHER?

Messrs. Editors:

IT may be of interest to state that our severe winter in this locality has been as unexpected and unprepared for by our small four-footed friends the musk-rats as by the human population. For many years our weather-wise people have based their predictions of severe or open winters on the manner in which the musk-rats built their houses. Last fall's indications were for a mild season, as the houses were exceptionally light and unsubstantial. Now the poor rats are suffering for their lack of foresight, and run about in the daytime, seemingly bewildered and dazed by the extreme cold, and fall easy victims to the small boys, who capture them with little trouble.

I have never been a believer in the superior knowledge of animals in foretelling weather, and this corroborates my ideas upon the subject. Respectfully,

E. C. MASON.

MADISON, WISCONSIN, *February* 19, 1885.

MEDICAL EXPERT TESTIMONY.

Messrs. Editors:

Referring to Dr. Hamilton's excellent article on "Medical Expert Testimony" in the March "Science Monthly," I am reminded of a very amusing incident reported in the "Daily Register" of this city a few months since. A negligence case was on trial in one of our courts. A physician was called as an expert, who testified that the plaintiff was suffering from the remote effects of an injury to the vaso-motor system of nerves, and would in time become insane. Being cross-examined with some severity, the doctor was asked, among other things, concerning his familiarity with Gross, "On the Recent and Remote Effects of Head-Injuries"; Lanery, "On Injuries of the Head"; Zehmayer, "On the Subsequent Effects of Nervous Shock"; and Carson, on "The Surgery of the Head," and he testified that he had read these books, and his library contained them all.

The opposing counsel called to the witness-stand a clerk from his office, who testified that the works above named were fictitious, and the titles were invented by him to expose the doctor's ignorance! In addition to Dr. Hamilton's very logical protest against the proposed appointment of a board of experts to be used on all occasions like a court crier or interpreter, I know of no more forcible protest than the above incident. These pedantic "experts" would be the only physicians who could afford to accept the position for its slender emolument, and men of Dr. Hamilton's caliber, who are the only men who ever *should* be called, would be wholly excluded! A. W. Gleason.

New York, *February* 20, 1885.

EDITOR'S TABLE.

PROGRESS AT HARVARD.

HARVARD UNIVERSITY is to be congratulated on its leadership in the important work of liberalizing the traditional college education. It has ended—or is on the way to ending—the narrow and intolerant policy of forcing upon all its students an old study not required by them, and the imperfect general acquisition of which has become a reproach to the institution, and the standing scandal of college education. Harvard has at last begun in earnest the work of putting Greek where it properly belongs, on the same basis as other studies. She has divested it of its arrogant claims, withdrawn the compulsion that has so long given it factitious consideration, and left it to be taken up and pursued like other subjects by those who value it. This is called waging war against the noble study of Greek; desecrating classical ideals, and destroying liberal education. It is quite the reverse. It is giving freedom to Greek; it is putting classics on their rightful foundation, and giving to education the liberality of greater liberty. But there is wailing in the classical camp. The newspapers are talking of the "fall of Greek," of "perilous experiments," of "momentous revolutions" and the sordid encroachments of the money-making spirit! And what has happened? Why, Harvard University has consented to accept of its candidates for admission a certain thorough and well-defined preparation in physics in place of the Greek formerly exacted. This is surely moderate, for they are not "fanatical iconoclasts" who have carried this reform to its present result in Harvard University. It is not true that this venerable institution has got on a useful-knowledge rampage and ordered all its dead-language books to be thrown into Boston Harbor. Those who desire to study Greek can still do so, but, by leaving it upon this basis, if there are fewer Greek students they are certain to be better ones. One would think that this consideration would weigh with the classicists, and that they would not distress themselves because their favorite study is to be elevated and yield more creditable results in the future. But, if they will be miserable over such a manifest step of improvement in dealing with their own subject,

we can not help it. Our ground of satisfaction is, that a formidable obstacle to the study of science has been got out of the way in an influential university, and that now it will be a good deal easier for other collegiate institutions to do the same thing.

THE SCYLLA AND CHARYBDIS OF ADMINISTRATION.

Mr. Frederic Harrison was perhaps not very far wrong when he spoke the other day of the position of comparative isolation which Mr. Spencer occupies, so far as his views on the proper sphere of government are concerned. There is probably no living philosopher, not the mere mouth-piece of a sect or school, whose general philosophical views command as wide assent as those of Mr. Spencer, but multitudes, who are willing to follow him when he discourses of evolution and of the relativity of knowledge, hold back when they are asked to accept the application which he makes of his general principles to practical questions of government. If, however, Mr. Spencer's philosophy rests on a sound foundation, as so many are prepared to admit, and if his views on the conditions of political and social well-being are legitimately deduced from the cardinal principles of that philosophy, then sooner or later the world must accept them or—suffer the consequences of rebellion against the teachings of right reason. Mr. Spencer can afford to wait for his vindication better, perhaps, than the world can afford to wait to adopt the plan of political salvation which he points out.

It may help to clear up the subject a little if we endeavor to show what the actual condition of things is, and what are the difficulties with which government, in the present unduly-comprehensive sense of the term, has to contend. We speak in the heading of this article of "the Scylla and Charybdis of administration." By Scylla we wish to signify the "spoils system," that under which the public offices are bartered for party services; by "Charybdis" we understand bureaucracy. Mr. Spencer says, "Steer away from both of these devouring monsters, by reducing the functions of government to a mere fraction of what they now are"; but the advice is not heeded. Our modern statesmen make straight for one or another of these sources of danger, or else try to steer between them—an experiment which generally results in damage from both sides.

The "spoils system" is too well known in this country to need much description. It consists essentially in making the hope of office, or of control in connection with the disposal of office, the mainspring of all political effort. What kind of political class this system tends to breed we know only too well. The type is the same, from the bar-room rowdy who trusts to his usefulness at election-times to secure him immunity from punishment when arraigned for assault or murder, up to the millionaire who buys himself a seat in the Senate. We see representatives of the system hanging round our city halls, waiting for their share of plunder, and meanwhile defiling rooms which ought to represent the decency and order of a great community with their rude and unsavory habits. We see them in the lobbyists and the pension agents, the men who advertise to procure situations for money, and all the other harpies that congregate at our national and State capitals. We see them in those members of Congress, not a few, whose whole idea of statesmanship is to watch, in the interest of their several localities, the progress of appropriation bills. We see them in influential journalists who make no effort to conceal the rage and scorn with which they are inspired by the very idea that office should be bestowed

otherwise than as a reward of political services. One of these, a year or so ago, bluntly expressed his innermost thought on the subject by saying that the effect of such civil-service reform as the Pendleton bill aimed at was to leave nothing for political ambition but—we must be pardoned if we quote the words exactly as given by the energetic editor—"a damned barren ideality." Another editor, not less energetic or able, sums up his objections to the present civil-service reform movement by calling it "pot-hook reform," holding it apparently beneath the dignity of a spoilsman to know anything about pot-hooks, or any other elements of a decent education. Enough that he should have known how to drum up a score of votes on election-day.

We see the results of the system, further, in the extreme inefficiency of legislation upon matters of national as opposed to matters of local consequence. An appropriation bill can always be put through. There are never wanting hands to roll that particular chariot along. Everybody seems to understand voting money. Everybody, with few exceptions, is ready to echo the cant phrases, the bogus formulas, about the importance of having the national Government represented in remote localities by costly public buildings, and extravagant mail services. Wherever a contract can be scented, it is easy to excite interest; but, when it is a simple matter affecting the national credit, the improvement of extradition treaties, the acquitting of a debt, the regulation of the consular service, the investigation of frauds on the republic, the case is very different; then it seems as if nobody could do anything, and matters are laid over from year to year. Anything more abortive or inane than a discussion on the tariff nobody could imagine. The advantage generally rests with the men who want high taxation, for the simple reason that they know what they want, and show an admirable consistency of purpose in laying burdens on the country at large for the benefit of themselves and their friends. The name this kind of thing goes by, strange to say, is not "plunder," but "protection." Until, however, those who believe in free trade have the courage to say so, the plunderers, who never lack for audacity, will have the best of it.

What the demands of the spoils system are upon the energies of cabinet ministers and others who ought to be attending to important duties, for which they are paid by the public, need hardly be dwelt upon. Those who have most experience in such matters will not contradict us if we say that three fourths of the time, and a larger proportion still of the energy of the heads of departments, are taken up, in one way or another, with questions of patronage, and that only the residue goes to considering how the public business can best be done. The office-seekers were a greater terror to Abraham Lincoln than the Southern armies, and, if the whole truth were known, it would be found that many a man has been hounded by them into his grave. Guiteau was but an extreme example of the audacity and shamelessness of the tribe. All the intermediate grades are kept full, and probably men are now known to the heads of the executive, not less impudent than Guiteau, though, happily, lacking his murderous fanaticism.

That relief should be sought from the terrors and horrors of the spoils system, in what is known as civil-service reform, is not surprising; and yet some of the arguments of those who oppose such reform are not without weight. They say that it is not desirable to form an official class; that it is not desirable to introduce into this country the stereotyped methods and the deadly routine of European officialism. They say that, where bureaucracy has thoroughly established itself, the office-

holder has great difficulty in realizing that the country was not created for him to govern and regulate; that he is a servant of the public is not in all his thoughts. Thay say that when men are virtually irremovable, save for gross misconduct, they generally become sluggish in the performance of their duties, and that in the higher officials this sluggishness becomes rank obstruction. They point to such an institution as the English post-office, which, during the *régime* of Rowland Hill, a man who was forced on it from without, exhibited a great degree of life and energy, but which, under his successors, shows the bureaucratic spirit in perfection, and is becoming as noted for its dullness and lethargy as once it was for intelligence and the spirit of progress. They say: Carry out the examination system consistently, apply it, as is done in England, to all branches and grades of the public service, and we shall in due time have here, not a flexible and self-adapting governmental machine such as we need, and as, to some extent, we have at present, but a vast and comprehensive mandarinism existing apart from, and (with the most benevolent purposes no doubt) presiding over our national life. They point to the intolerable airs which the official classes give themselves in most European countries—airs implying a definitely established superiority on the part of messieurs the functionaries over the citizens with whom they come into contact. They add that, however great an evil office-seeking may be to-day, it is after all confined to a small percentage of the people, those who, by reason of the political services rendered by themselves or their friends, conceive themselves entitled to some consideration in the distribution of patronage; whereas if commissioners and examiners are employed to perambulate the country, advertising the public service more or less in every city, town, and hamlet, the number of those whose minds will be more or less unsettled by the thought of perchance obtaining a government situation will be vastly greater. In such terrible colors is the Charybdis of bureaucracy painted by men who, for their own part, have no dread of the Scylla of the spoils system.

Well, the picture they draw is not very unlike the reality. We have as yet in this republic but a partial measure of so-called civil-service reform; but, if the time should ever come that the English system should be adopted in its entirety, there can be no question that, in the course of half a generation, we should have among us an official class such as we do not wish to see—men to whom the traditions and usages of their several departments would be of much greater moment and weight than the requirements of the public, or than the dictates of practical common sense. The public business would not be done on business principles, but on "departmental" principles—something very different. And, just as the governmental machine grew in size and complexity, would it more and more begin to constitute, in the eyes of those operating it, an end in itself. To master the technique, so to speak, of a department would take some years of application; and nothing would be easier than for the permanent officers to persuade political heads, who might wish to introduce reforms, that the machine was working as well as could be expected, and that to try and make it work otherwise than it was doing would throw everything into confusion. Of course, it would seem like great temerity on the part of a man of no experience to combat the views of a most respectable and apparently intelligent gentleman, who had perhaps grown gray in the performance of his departmental duties; and thus many an enterprise of pith and moment would turn its course awry, and lose the name of action, as the Prince of Denmark once thoughtfully observed. It would not,

however, be "the pale cast of thought" that would "sickly o'er" the good resolutions of reformers, but simply stall-fed obstruction that would crowd them aside. That things will come to such a pass in this country we are not prepared at present to predict. It is by no means certain that the "reform" principle will gain any more victories. There is much impatience at present of the difficulties it interposes in the distribution of patronage. We have, however, with our present ideas of the functions of government, just the two evils to choose between—the Scylla of the spoils system and the Charybdis of bureaucracy. Of course, we may try to combine the two, so as to have some experience of the evils of both; but the probability is, that sooner or later one or other will decisively carry the day.

Now, Mr. Spencer says: The whole trouble arises from your having so many offices to dispose of, and that comes of your having crowded so many functions upon the Government. You have brought on a condition of things dangerous to the peace and stability of the state. Had you left to private initiative and responsibility a very large part of what you now place on the shoulders of the Government, the office-seeking nuisance could never have grown to its present dimensions, nor could bureaucracy ever have been the incubus it now is on the life and energies of many communities. The time has come to unload, to repeal laws rather than to enact new ones. The organic growth of society is checked when you resort to what may, by comparison, be called the mechanical methods of legislation and governmental control. It is under the *régime* of freedom, not under that of compulsion, that social bonds are knit. If you would have virtue to grow strong, you must let it have its full value as virtue in the world; you must not try to equalize all varieties of character by repressive laws. If, however, you are determined to abandon organic methods, and to operate exclusively by means of the policeman's truncheon, more or less politely concealed, prepare yourselves for great convulsions, for the condition you will induce will not and can not be one of stable equilibrium.

The warning has been uttered. It remains to be seen whether it will be as the voice of one crying in the wilderness, or whether it will prove the signal for a new awakening of political intelligence, and the formation of a new and higher conception of the social state.

LITERARY NOTICES.

The Rise of Intellectual Liberty, from Thales to Copernicus. By Frederick May Holland, author of the "Reign of the Stoics." New York: Henry Holt & Co. Pp. 458. Price, $3.50.

The author of this book has chosen a magnificent subject, and, although it is formidable in extent and much of it involved in obscurity, and all of it complicated with great questions of history and human progress, he has yet been able to throw much new light upon that liberalization of thought which went very unsteadily forward during twenty-two hundred years, before the great modern movement of the development for intellectual liberty. The work is a delineation of tendencies, a series of sketches of the great minds who at different times and under varied circumstances, and with unequal effect, have struck for independence of thought, a presentation of the counter-forces that have antagonized intellectual liberty, and an account of the working of all those larger agencies which have in different degrees hindered or promoted freedom and independence of thought. Without having subjected the work to critical scrutiny, we are much impressed by the evidence it shows of extensive and conscientious labor, the freshness and interest of its chief subject-matter, the untrammeled treatment of the subject, and the vigor of the portrayal of that long and agonizing conflict with bigotry and intolerance, religious and political, public and private, which is the price of our modern liberty of thinking.

It is a noteworthy fact that the work has not been executed under the bias of any preconceived theory. The author says: "I did not start with the intention of proving anything; and it was only when I was ready to write the last chapter that I found myself justified in drawing the conclusions set forth." This state of mind is undoubtedly favorable to impartiality of statement, and can hardly fail to inspire the reader with a considerable measure of confidence in the trustworthiness of the author's representations.

The author indicates the manner of execution of his volume in the remark: "I have tried to collect the important facts, especially such as had not been stated in English, to arrange them in their historic relations not yet fully delineated in any language, and then to let them tell their own story without needless comment."

Second Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1880–'81. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 514.

The researches of this bureau are bringing to light an abundance of information in regard to the arts, institutions, languages, and opinions of the American Indians.

Mr. Frank H. Cushing's work especially has attracted wide attention, though the accounts as yet published cover only a small part of his observations. He contributes to this volume a paper on "Zuñi Fetiches." The Zuñi worships in general the mysterious powers of Nature, and especially the beasts, which he regards as most nearly related to himself, and hence in position to mediate between him and the more remote powers. He believes that the hearts of the beasts of prey have the power to take away the strength of the game-animals, thus making them easy to capture. Without recourse to the proper fetiches, so as to obtain the aid of this influence, the Zuñi deems it useless to attempt the chase of game-animals. The favorite fetiches are mineral concretions, or eroded pebbles having some resemblance to the forms of animals, which is usually heightened artificially. The priests assert that these are the actual bodies, petrified and shrunken, of the animals which they resemble, and that their hearts still live in the fetiches, although their bodies are turned to stone. A flint arrow-head is usually bound to the back or side of the figure, and strings of beads are sometimes hung around it. The fetiches of the beasts of prey are the most esteemed, and the name of this class, *Wé-ma-we*, is used for all fetiches.

Mrs. Erminnie A. Smith has embodied in a paper a large number of Iroquoian traditions relating to mythical gods and other supernatural beings, the practice of sorcery, and the origins of various phenomena, together with descriptions of religious festivals, and miscellaneous tales of adventure. Echo was the Mars of the Iroquois. In their wars with other tribes, by repeating among the hills their cries of "*Go-weh!*" he secured for them almost certain victory. The Thunder-god has been regarded as a special protector of this people. Among the supernatural beings were the Stone Giants, mortal enemies of men; the Pygmies, a friendly race; and the Great Heads, which were borne by their long hair, as by wings, on missions of mercy or of destruction. The aim of the essay on "Animal Carvings from Mounds in the Mississippi Valley," by Henry W. Henshaw, is to show that, of these carvings which can be identified, none represent animals which are not indigenous to the Mississippi Valley, and that the art-culture of the mound-builders has been greatly overestimated. Dr. Washington Matthews, U. S. A., describes briefly the tools and processes with which Navajo silversmiths produce a variety of quite elaborate articles. "Art in Shell of the Ancient Americans" is treated at considerable length by William H. Holmes. Fifty-seven plates accompany the paper, showing forms and patterns of dishes, implements, beads, wampum-belts, engraved gorgets, etc. Many extracts from early writers are given, describing the use of wampum-belts as ornaments, currency, and as tokens of treaties. Two catalogues of articles obtained from Zuñi and other Pueblos of New Mexico and Arizona, by James Stephenson, occupy the last 150 pages of the volume. These collections contain 3,905 specimens, consisting largely of pottery, but including basketry, implements, clothing, images, etc. The decoration of much of the pottery, as shown

by the figures, is elaborate and often graceful. The whole volume, especially these catalogues, is lavishly illustrated, containing 154 full-page plates, many of them colored, besides thirty-five figures in the text.

Sixth Annual Report of the State Board of Health of Illinois, John H. Rauch, M. D., Secretary. Pp. 324.

Among the peculiar functions of this board, with the operation of which the present report largely deals, is that of the execution of the act to regulate the practice of medicine in the State. The medical profession is thus brought within the scope of sanitary laws, and under responsibility to a body with power. It is the duty of the board to issue certificates authorizing practice in the State to "all who furnish satisfactory proof of having received diplomas or licenses from legally chartered medical institutions in good standing." It became necessary to determine what was "good standing," and what institutions came under it. To define the term, the consensus of leading members of the profession and the faculties of medical colleges, in answer to letters soliciting their opinions, was taken. Then test questions were sent out to the colleges, the answers to which determined whether they came up to the standard. In evidence of the improvement in the standards of medical education, it is stated that, whereas in 1880 fourteen medical schools in the United States required of candidates for admission evidences of preliminary education, ninety schools now require them; eighty schools give instruction in hygiene, to seventeen in 1880; and twenty-three make attendance on three or more courses of lectures a condition of graduation, to eight in 1880, while fifty-six others are making tentative efforts toward the same point. The board is issuing a series of "Preventible Disease Publications," to which have been added during the year circulars on the prevention and control of scarlet fever and of diphtheria, and upon the sanitary features of typhoid fever and the prevention of its spread. These publications are in demand, and are often reprinted in the newspapers. Some of them have also been issued in German and in the Scandinavian languages. Nearly half the volume of the report is occupied with the lists of licensed physicians and midwives.

Notes on the Opium-Habit. By Asa P. Meylert, M. D. Third edition. New York: G. P. Putnam's Sons. Pp. 47.

The purpose of this publication is to make a plea for more humane methods of treating the opium-habit than have heretofore prevailed. The author believes that no disease known to man demands such varied treatment as this of opium. "The habit was formed to relieve a single symptom of diverse disorders, namely, pain. . . . The original disease often remains in abeyance, ready to break forth when the drug is discontinued, and, if this disease be not cured, the habit is not cured." Again, the habit itself provokes disease, and this must be treated variously. There is, therefore, no specific for the opium-habit. There is, likewise, no quick cure for it. The present edition of the book has been thoroughly revised and largely rewritten. Since the first publication of the "Notes" the author has found the opium-habit more widely prevalent than was first surmised.

Comparative Physiology and Psychology. By S. V. Clevenger, M. D. Chicago: Jansen, McClurg & Co. Pp. 258. Price, $2.

The secondary title of this book characterizes it as "a discussion of the evolution and relations of the mind and body of men and animals." Its intention is to elaborate, as far as possible, a practical mental science which will reconcile the observations of anatomists, psychologists, and pathologists, with direct reference to the more intelligent treatment of insanity. Insanity, the author believes, will be better understood, and its treatment will become more scientific in proportion to the development of psychology, based upon comparative microscopic anatomy, and a physiology into which molecular physics shall enter more in the future. The system under which the metaphysicians have studied mental workings is regarded as having been so insufficient and one-sided, and their deductions often so absurd, as to discourage honest investigators and throw discredit on the pursuit. But a more sensible psychology has been evolved under the influence of such thinkers as Herbert

Spencer and Darwin, and of the investigators who have worked in their spirit. The author proposes to apply an extension of Mr. Spencer's principles to the study, and starts out with the proposition that mental phenomena are modes of chemical energy.

Annual Report of the Chief Signal-Officer to the Secretary of War for the Year 1883. Washington: Government Printing-Office. Pp. 1,164, with Forty-eight Plates.

Thirty enlisted men were instructed in signal-service duties at Fort Myer. Efforts were made to add to the number of officers who can be depended upon for weather-predictions. The stimulus which the work of the bureau has given to the study of meteorology is noticed with gratification. The preparation of a text-book containing an elementary course of meteorology has been begun, and a new treatise from a philosophical, mechanical, and deductive point of view is in hand. From 84·4 to 88·3 per cent of the "indications" published during the previous ten years to 1883 were verified, and from 75 to 83·9 per cent of the cautionary signals displayed since 1874. The scientific work of the bureau was pursued in applications too numerous to be named specifically here. The number of stations had to be decreased on account of insufficiency of appropriations; but 376 were in operation in June, 1883, and work for the service was done by 19 officers and 500 enlisted men. Reports were received from 335 foreign stations, 59 steamship lines, 605 vessels, and 339 voluntary observers. The publications of the service include the "Monthly Weather Review," the "Monthly Summary and Review," the "International Bulletin," the "Meteorological Record," and several special papers.

Osteology of Numenius Longirostris. By R. W. Shufeldt, U. S. A. Pp. 32, with Plates.

Numenius Longirostris is the long-billed curlew, which Captain Shufeldt observed alive at Egmont Cay, Florida, and studied anatomically in Wyoming. Besides minute descriptions of this bird, his monograph includes notes upon the skeletons of other American *Limicolæ*.

The Asiatic Cholera, as it appeared at Suspension Bridge in July, 1854, and its Lessons. By Frank H. Hamilton, M. D. Pp. 26.

The outbreak described was sudden, violent, and narrowly limited in its spread to ground of a peculiar physical condition. The disease appears to have been introduced by a company of German immigrants, who were "dumped" upon the banks of the river from the cars, and was propagated with wonderful speed among the people, mostly employed on the suspension-bridge, living in the favorable locality. Dr. Hamilton's conclusions appear to agree, generally, with the view of Dr. Pettenkofer, that, while the implanting of a germ may be essential to the inception of cholera, the violence of the attack and the rapidity of propagation are largely dependent on soil-conditions.

Comparative Study of the New High German Language, Theoretical and Practical. By William W. Valentine. Richmond, Va. Seventy specimen pages.

Professor Valentine believes that the modern languages, especially German, are as capable of philosophical study as any of the ancient tongues which have been avowedly treated in that manner, and whose capacity for such treatment has been extolled, and that such study of them is most valuable as a means of intellectual training. The present pamphlet is intended to present an outline or suggestions, indicating the principles on which the study should be based, and the manner in which it can be pursued, and is offered tentatively in anticipation, provided the plan finds favor, of the preparation of a full treatise.

Description of Carcharodon Carcharias. By W. G. Stevenson, M. D. Poughkeepsie, N. Y. Pp. 8, with Plate.

The various descriptions given of this fish, which is otherwise known as the "man-eater shark," are so very imperfect and confusing that the author says, with Professor D. S. Jordan, that "there is no good description of the animal extant." A shark of this species was taken in August, 1883, near Nantucket, and specially examined by Dr. Stevenson. The present monograph is the fruit of this study.

Black and White: Land, Labor, and Politics in the South. By T. Thomas Fortune, Editor of "The New York Globe." New York: Fords, Howard & Hulbert. Pp. 310. Price, $1.

The author is a thinking man, and a molder of opinion among the colored people. He views the situation in the South, as the war and reconstruction have left it, and the present finds it, from the point of sympathy with his race; yet, with the mental breadth of a man educated in public affairs, he is able to discern that there are other sides to the question. He urges national compulsory education as a means of mitigating the dangers threatened by the existing situation; but the main purpose of his book is to show that the social problems in the South are, in the main, the same as those which afflict every other civilized country; that the future conflict in that section will not be racial or political, but between capital and labor; that poverty and misfortune make no invidious distinctions of race, color, or previous condition, but that wealth unduly centralized afflicts all alike; and that some unity of organization and action should be secured between the labor elements' of the whole United States.

Degeneration the Law of Disease. By L. A. Merriam, M. D Omaha, Neb. Pp. 8.

This is the substance of a paper read before the Medical Society of Omaha in September last, the import of which is to apply the theory of evolution to the study of disease. It regards disease as consisting in a reversed evolution, or degenerative changes; as induced by processes of degeneration of the tissues and functions, and in turn inducing such processes.

Protection and Communism. "Questions of the Day," No. 15. By William Rathbone. New York: G. P. Putnam's Sons. Pp. 42. Price, paper, 25 cents.

This pamphlet aims to show that the protective tariff has caused the sudden alternations between hard times and good times in the United States, has caused communism to increase in this country, while it has been decreasing in England, and has made our rich men richer and our poor poorer. The writer believes that, if the United States had not adopted protection twenty years ago, they would lead England in commercial prosperity to-day, and could gain the same position with free trade in another twenty years.

Ottawa Field-Naturalists' Club. "Transactions," No. 5. 1883-'84. Ottawa, Canada: Citizen Printing and Publishing Company. Pp. 152.

The club has been active during the year covered by this number of its "Transactions." During the summer, it made four regular excursions, and numerous minor excursions were made by its branches; in the winter, seven *soirées* were held, at which papers were read and reports presented. The membership has increased from 108 to 128. The "Transactions" contains the inaugural address of the president, H. B. Small, with papers describing observations made in the immediate vicinity, to which the work of the club is confined, and reports of the six branches into which the club is divided.

The Sun. Vol. I, No. I, January and February, 1885. Kansas City, Mo.: C. T. Fowler. Pp. 28. Price, 20 cents, or $1 per annum.

"The Sun" is a bi-monthly paper devoted to co-operation. The present number has a portrait of Herbert Spencer, and discusses as its special subject, "Co-operation; its Laws and Principles," which is considered under twenty-five sub-heads. The next number will be devoted to "The Reorganization of Business" on a labor instead of a usury basis.

Journal of the New York Microscopical Society. Edited by Benjamin Braman. Vol. I, No. I, January, 1885. New York: 12 College Place. Pp. 32. Price, $1 a year (nine numbers).

The title indicates the object, and to some extent the character of the publication. The present number contains the proceedings of the society named, for October, November, and December last; a paper on "Electrical Illumination in Microscopy," by E. A. Schultze; discussions bearing on pollen-tubes; "Miscellanea"; and an index to articles in various publications of interest to microscopists.

Original Researches in Mineralogy and Chemistry. By J. Lawrence Smith, Membre Correspondant de l'Institut de France (Académie des Sciences), etc. Printed for presentation only. Edited by J. B. Marvin, B. S., M. D. Pp. 630. Louisville, Ky.: John P. Morton & Co.

The title of this work indicates the chief line of research pursued by the author of its papers in his long and active career as an original scientific inquirer. We printed in the "Monthly" for December, 1874, an interesting sketch of his busy life, and an account of his more important investigations. He issued a volume of "Scientific Researches" in 1873, which contained the most valuable of his contributions up to that date. The present volume is a reprint with but very little editorial change of his principal papers published since that time. It is a valuable record of recent results in mineralogical chemistry; and especially with reference to meteorites, which was a prominent subject of study with Dr. Smith.

Poems of Sidney Lanier. New York: Charles Scribner's Sons. Pp. 246. Price, $2.50.

From "The Independent," "Scribner's," "Lippincott's," "Appletons'," and other magazines, these occasional poems have been collected by the widow of the poet. Most of them are characterized by a tender sadness, as might be expected from a writer who had known more pain than joy. "The Symphony" and "Psalm of the West" are of a more vigorous type, and a humorous vein appears in several dialect poems. The poems are preceded by a memorial sketch by William H. Ward, who rates Sidney Lanier as "much more than a clever artisan in rhyme and meter."

Man in the Tertiaries. By Edward S. Morse. Salem, Mass.: The Salem Press. Pp. 15.

This is the vice-presidential address delivered before the Anthropological Section of the American Association, over which the author presided at the last meeting of the Association in Philadelphia. It reviews the evidence in favor of the high antiquity of man on the earth. An abstract of the address was published in "The Popular Science Monthly" for December.

The Agricultural Grasses of the United States. By Dr. George Vasey. The Chemical Composition of American Grasses. By Clifford Richardson. Washington: Government Printing-Office. Pp. 144.

This report is a contribution toward answering the question whether we can not select, from our wild or native species of grass, such as may be cultivated in those parts of the country unprovided with suitable kinds. The native grasses of the Territories receive most attention, and some information concerning the herbage-crops in the Gulf States is given. A large number of grasses are described, and one hundred and twenty varieties are figured in full-page plates.

United States Publications: Monthly Catalogue. Vol. I, No. I, January, 1885. Washington, D. C.: J. H. Hickox. Pp. 22. Price, $2 per annum.

The Catalogue will include the titles of publications of every description printed by order of Congress, or of any of the departments of Government, during the month preceding the date of its issue.

The Story Hour. For Children and Youth. By Susan H. Wixon. New York: Truth-Seeker Company. Pp. 222.

A collection of articles, with elegant illustrations, from the youth's department of the New York "Truth-Seeker." It has been the author's aim to produce a book "that, while pleasing, will awaken healthy thought, and stimulate to right endeavor." It is claimed to be "pure in tone, entirely free from superstitious taint, and well calculated to broaden, brighten, and strengthen the growing mind."

Proceedings of the American Society of Microscopists. Seventh Annual Meeting, Rochester, N. Y., August, 1884. Buffalo: Bigelow Brothers. Pp. 300.

Several of the papers of the "Proceedings" are given in full, among them an account, by Dr. George E. Fell, of the discovery by the aid of the microscope of an interpolation in a written contract. The opening address of President Jacob D. Cox reviews a part of the work of Robert B. Tolles in the improvement of the microscope, and is followed by a memoir of Mr. Tolles, by George E. Blackham.

Geonomy: Creation of the Continents by the Ocean-Currents. By J. Stanley Grimes. Philadelphia: J. B. Lippincott & Co. Pp. 116.

The author of this book is introduced by the Rev. W. R. Coovert as a writer who published a book to advocate theistic evolution—"a volume which was more Darwinian than Darwin himself, excepting that it was decidedly and avowedly theistic"—eight years before the "Origin of Species" was issued. He has also published a work bearing on spiritism and mesmerism. The purpose of the present volume is to expound a theory that all the elevations of the earth's crust have resulted from the sinking of the ocean-basins, or of smaller local basins, beneath the weight of the sediment; that this sediment was collected by elliptical currents working in the waters, of which three pairs are supposed, causing three pairs of sinking basins, corresponding with the North and South Atlantic, the Pacific, and the Indian Ocean basins; that the fluid or plastic lava forced from beneath the sinking basins was driven under the crust in the interoceanic spaces, and, raising them up, created three pairs of continents. The configuration and relative situations of the continents and ocean-basins, etc., are accounted for in other propositions.

Sunlight. By the author of "The Beginnings," "The Biography of Dust," etc. Pp. 70.

A series of letters, by Mr. N. P. Malet, first published in "The Northern Whig," of Belfast, Ireland, in elucidation of a theory that light, not heat, is the primary and potent force, separate from heat. From his premises the author deduces that the heat attributed to the sun is in reality generated by the action of the sun's light on the gases of the earth. Extending his theory to a general cosmogony, he holds that the natural beginnings of this earth and the other planets and asteroids were separate, nebulous gaseous masses gravitating in space, till they were in turn sensible to the light of the sun, and became the worlds of this solar system. Vegetation is accounted for by supposing that the seeds of the first plants were brought to the earth by vapors or gases from other worlds.

An Account of the Progress of Chemistry in the Year 1883. By Professor H. Carrington Bolton. Washington: Government Printing-Office. Pp. 32.

The "Account" has been prepared for the Smithsonian Report for 1883, and is here given in separate form. It records the more important discoveries in chemistry, and the new processes and applications brought to light during 1883, arranged under the heads of "General and Physical," "Inorganic," and "Organic," a chemical bibliography of the year, and notices of chemists who died during the year.

Rural Schools; Progress in the Past; Means of Improvement in the Future. Washington: U. S. Bureau of Education. Pp. 90.

This is Number 6 of the "Circulars of Information" of the Bureau of Education for 1884. It was prepared by Miss Annie T. Smith, under the direction of the Commissioner of Education, to collate the information accessible on the subject. It embraces a review of the present condition of ungraded schools; comparisons of the courses of study and the daily programme for the distribution of time and subjects in schools of Michigan, Virginia, and Wisconsin, with those employed in France, Switzerland, Prussia, and Austria; papers on "Pedagogic Principles," and suggestions on special points in teaching.

The Composition and Methods of Analysis of Human Milk. By Professor Albert R. Leeds, Ph. D. Pp. 24, with Plates.

Professor Leeds here compiles the analysis of eighty specimens of human milk. Considerable variety is exhibited in the results. Many of the samples appear to contain a body hitherto unknown, and not yet isolated or determined, which gives in the ethereal extract of the copper albuminate an emerald-green solution. While the superficial physical characteristics of the mother are not shown to be related to differences in the composition of the milk, an intimate connection appears with actual physical conditions. The samples obtained from women of over-robust habit were not so rich in albuminoids as those from pronounced anæmic women. Generally speaking, the best milk was obtained from lean women in good physical condition.

"The Journal of Mycology," Vol. I, No. 1, January, 1885. W. A. Kellerman, Ph.D., J. B. Ellis, and B. M. Everhart, editors. Manhattan, Kansas. Monthly. Pp. 16. Price, $1 a year; single numbers 15 cents.

The "Journal" is devoted exclusively to mycological botany, and, while giving special attention to descriptions of North American species of fungi, will publish accounts of the current literature pertaining to the subject. The present number contains original descriptions of twelve new fungi from Kansas and fifteen from Iowa, with notices of "North American Geasters," and of other fungi of Kansas.

Notes on the Progress of Mineralogy in 1884. By H. Carvill Lewis. Philadelphia:

Professor Lewis is in the habit of preparing, as chief in that editorial department, monthly summaries for "The American Naturalist," of the discoveries and new ideas in mineralogy. The present pamphlet is the collection of all of these summaries that appeared during 1884, and presumably includes all that occurred worthy of special notice, in mineralogical research, during the year.

Mind in Medicine. By Rev. Cyrus A. Bartol, D. D. New York: M. M. Holbrook. Pp. 39. Price, 25 cents.

This pamphlet embodies the substance of two sermons preached by the author on successive Sundays extolling the value of a sound mind as an element of health, and the virtue of mental remedies for disease. "Bodily strength, fresh color in the cheeks, more alert steps, and cheerier tones," says he, "are revelations of mind shining through the body. . . . You sail for Porto Rique! Well, a person not airy, but atmospheric, may be a warmer climate, relieving your ailments better than that island, or Mentone, Pau, or St. Augustine."

"Babyhood," December, 1884. Leroy M. Yale, M. D., and Marion Harland, Editors. 18 Spruce Street, New York. Pp. 32. Price, 15 cents a number; $1.50 a year.

"Babyhood" is devoted exclusively to the care of infants and young children, and the general interests of the nursery. Its purpose is to become a medium for the dissemination of the best thought of the time on all subjects connected with the needs of the child, embracing in its scope the period from the day of birth to the age when the nursery is supplanted by the school-room. There is certainly a place for such a magazine.

PUBLICATIONS RECEIVED.

Sex in Mind and in Education. By Henry Maudsley, M. D. Syracuse, N. Y.: C. W. Bardeen. Pp. 36. 15 cents.

Calisthenics and Disciplinary Exercises. By E. V. De Graff. Syracuse, N. Y.: C. W. Bardeen. Pp. 39.

University of Nebraska. Seventh Biennial Report of the Board of Regents. Pp. 32. The Chancellor's Report. Pp. 75. Lincoln, Neb.

State Inspector of Oils, Minnesota. Special Report on Illuminating Quality. By Henry A. Castle, State Inspector. St. Paul. Pp. 24.

Building for the Children in the South. By Rev. A. D. Mayo. Washington: Government Printing-Office. Pp. 16.

Cremation scientifically and religiously considered. By Henry Houston Bonnell. Philadelphia: D. C. Chalfant. Pp. 13.

Bulletin of the Washburn College Laboratory of Natural History. Edited by Francis W. Cragin. Vol. I, No. 2. Topeka, Kansas. Pp. 84, with Two Plates. 20 cents.

An Account of the Progress of Anthropology in the Year 1883. By Professor Otis T. Mason. Washington: Government Printing-Office. Pp. 43. Anthropological Notes in the "American Naturalist." By Professor Otis T. Mason.

Commissioners for the Erection of the Public Buildings, Philadelphia. Report for 1884. Pp. 32.

Supplemental Report of the Railroad Commission, Tennessee. John R. Savage, Chairman. Nashville: A. B. Tavel. Pp. 31.

"The Medical Analectic." Monthly. Walter S. Wells, M. D., Editor. January, 1885. New York: G. P. Putnam's Sons. Pp. 48. $2.50 a year.

Illinois State Board of Health. Report of Proceedings. Springfield, Ill. Pp. 19.

Catalogue of the New Orleans Exhibit of Economic Entomology. By Charles V. Riley. Washington: Judd & Detweiler. Pp. 95.

Report of the Entomologist, U. S. Department of Agriculture, for 1884. Washington: Government Printing-Office. Pp. 150.

Message of John M. Hamilton, Governor of Illinois. Springfield: H. W. Rokker. Pp. 21.

Evolution. By George D. Armstrong. Norfolk, Va. Pp. 22.

Connecticut Agricultural Experiment Station. Report for 1884. New Haven: Tuttle, Morehouse & Taylor, State Printers. Pp. 130.

A Correlation Theory of Color Perception. By Charles A. Oliver. Philadelphia. Pp. 29.

Rose Polytechnic Institute, Terre Haute, Ind. Third Annual Catalogue. Pp. 38.

A Study of the Nutritive Value of Branny Foods. By N. A. Randolph, M. D., and A. E. Roussel, M. D. Philadelphia. Pp. 20.

Contributions from the Chemical Laboratory of Harvard College. By Charles A. Maybery and others. Pp. 16.

The Geology of Bermuda. By William North Rice. Washington: Government Printing-Office. Pp. 32, with Plates.

Wesleyan University. Report of the Curator of the Museum. Pp. 8.

On the so-called Bird-Track Sculptures in Ohio. A Glacial Pebble, Fired Stones, and Prehistoric Implements. Impression of the figures on a "Meday stick." All by Daniel G. Brinton, M. D. Philadelphia.

On the Xinca Indians of Guatemala. By Daniel G. Brinton, M. D. Pp. 9.

Bulletin of the Iowa Agricultural College. By Charles E. Bessey. Pp. 64.

Diccionario Tecnológico (Technological Dictionary). English-Spanish. Part XI. New York: N. Ponce de Leon. Pp. 64. 50 cents.

The Spanish Treaty opposed to Tariff Reform. New York Free Trade Club. New York: G. P. Putnam's Sons. Pp. 31.

Normal Language Lessons. By S. J. Sornberger. Syracuse, N. Y.: C. W. Bardeen. Pp. 81. 50 cents.

Underground Conduits. Report of International Electrical Exhibition. Philadelphia: Franklin Institute. Pp. 56.

Fire and Burglar Alarms and Annunciators. Report of International Electrical Exhibition. Philadelphia: Franklin Institute. Pp. 16.

Municipal Administration. By Robert Matthews. Rochester, N. Y. Pp. 16.

Alabama Weather Service. January, 1885. Agricultural and Mechanical College. Auburn. Pp. 17.

Whitestown Centennial Celebration. Historical Discourse. By Charles Tracy. Pp. 16.

Dynamite and Extra-Territorial Crime. By Francis Wharton, LL. D. Philadelphia. Pp. 28.

Symbolism and Science. By Lloyd P. Smith. Philadelphia: Privately printed. Pp. 28.

Aims and Methods of the Teaching of Physics. By Professor Charles K. Wead. Washington: Government Printing-Office. Pp. 158.

"The Inland Monthly." Vol. I, No. 2. Columbus, Ohio. Pp. 16. 15 cents a copy; $1.50 a year.

The Geological and Natural History Survey of Minnesota. N. H. Winchell, State Geologist. First Annual Report, 1872. Pp. 130. with Plates. Tenth Report, 1881. Pp. 260, with Plates. Eleventh Report, 1882. Pp. 220, with Maps. Twelfth Report, 1883. Pp. 384, with Plates.

Mind-Reading and Beyond. By William A. Hovey. Boston: Lee & Shepard. Pp. 201.

American Historical Association. Report of the Organization and Proceedings. By Herbert B. Adams, Secretary. Pp. 44. 50 cents. Studies in General History and the History of Civilization. By Andrew D. White. New York: G. P. Putnam's Sons. Pp. 28. 50 cents.

Resultados del Observatorio Nacional Argentino. (Results of the Argentine National Observatory.) By Benjamin A. Gould, Director. Vol. II, 1872. Pp. 296. Vol. III, 1873. Pp. 510. Vol. IV, 1873. Pp. 588. Buenos Ayres: Pablo E. Coni.

Catalogo de Zonas Estelares. (Zone Catalogue of Mean Positions of Stars.) Observed at the Argentine National Observatory. By Benjamin A. Gould. Vol. VII. Pp. 440. Vol. VIII. Pp. 424. Cordoba, Argentine Republic. Published at the Observatory.

"The Sanitary Engineer." Conducted by Henry C. Meyer. Vol. X. June to November, 1884. 140 William Street, New York. Pp. 612. $3.

Our Bodies, or How we Live. By Albert F. Blaisdell, M. D. Boston: Lee & Shepard. Pp. 285. 60 cents.

The Fallacy of the Present Theory of Sound. By Henry A. Mott, Jr. New York: John Wiley & Sons. Pp. 103. 50 cents.

The Mentor. By Alfred Ayres. New York: Funk & Wagnalls. Pp. 211.

The Care of Infants. By Sophia Jex-Blake, M. D. New York: Macmillan & Co. Pp. 108. 40 cents.

Alice's Adventures in Wonderland, and through the Looking-Glass. By Lewis Carroll. New York: Macmillan & Co. Pp. 192 and 224. 50 cents paper, 75 cents cloth.

Controlling Sex in Generation. By Samuel Hough Terry. New York: Fowler & Wells Company. Pp. 147. $1.

School-Keeping. How to do it. By Hiram Orcutt. Boston: New England Publishing Company. Pp. 244. $1.

Serapis. A Romance. By George Ebers. New York: William S. Gottsberger. Pp. 387. 90 cents.

Representative American Orations. By Alexander Johnston. New York: G. P. Putnam's Sons. Three vols. Pp. 282, 314, 405. $3.75.

Original Researches in Mineralogy and Chemistry. By J. Lawrence Smith. Edited by J. B. Martin, B. S., M. D. Louisville. Printed by John P. Morton & Co. 1884. Pp. 630.

The Rise of Intellectual Liberty from Thales to Copernicus. By Frederick May Holland. New York: Henry Holt & Co. 1885. Pp. 458. $3.50.

The Correspondence and Diaries of the late Right Hon. John Wilson Croker, LL. D., F. R. S., from 1809 to 1830. Edited by Louis J. Jennings. In two vols., with portrait. New York: Charles Scribner's Sons. 1884. Pp. 584 and 572.

Smithsonian Meteorological and Physical Tables. By Arnold Guyot. Fourth edition. Washington: Smithsonian Institution. Pp. 738.

Mining Camps. By Charles Howard Shinn. New York: Charles Scribner's Sons. Pp. 316. $2.

Diluvium; or, the End of the World. By George S. Pidgeon. St. Louis: Commercial Printing Company. Pp. 175.

The Patriarchal Theory. Based on the Papers of the late John Ferguson McLennan. Edited and completed by Donald McLennan. London: Macmillan & Co. Pp. 355. $4.

Mortality Experience of the Connecticut Mutual Life Insurance Company, 1846 to 1878. Hartford, Conn. Pp. 85, with Plates.

Tertiary Vertebrata. Book I. By E. D. Cope. Washington. U. S. Geological Survey of the Territories. Pp. 1009, with nearly 100 Plates.

POPULAR MISCELLANY.

Psychology of the Chimpanzee.—Dr. C. Pitfield Mitchell has published a "Study of the Psychology of the Chimpanzee," which he has made upon a specimen in captivity at the Central Park Menagerie, New York. On being introduced, the animal offers his right fore hand, and, grasping one of the fingers of his visitor, attempts to put it in his mouth. The extension of the hand, in meeting an acquaintance, is made with a pleased look of recognition, unmistakably the outcome of gratified social feeling, and is often accompanied with a presentation of the back to be scratched. The chimpanzee, seated in a chair at table before a bowl of milk, grasps the spoon with his right fore-hand, and feeds himself, wiping his lips with a napkin held in his left fore-hand. In using the spoon, the co-ordination of movements lacks precision, but none of the milk is spilled;

and, when the spoon is taken away, he whimpers to have it returned, but does not seem inclined to drink in the natural way. The outer and visible signs of laughter are comparatively simple; that species of laughter which is caused by the perception of incongruities was never witnessed, although a few attempts were made to evoke it, and although monkeys and dogs are known to be sensitive to ridicule. When disappointed, as when a piece of banana was taken away from him, the animal sulked, became angry, cried, and shook his hands. When introduced to his image in the looking-glass, he seemed fixed for an instant with surprise, then looked to the back of the mirror, and began to bite the frame and pull an attached cord. "Advancing to the front and examining the reflection of his person with evident satisfaction, he commenced, with absurdly sincere intentions, to make effusive demonstrations of love. He repeatedly pressed his lips and tongue to the glass, and, erecting himself to his full height, strutted, and grinned, and made obeisance in most ridiculous and amusing fashion. He was once seen to make signs to his image by spasmodic movements of his lips, without uttering any audible sound. He again looked behind the mirror, and again fell to biting the frame. He became still more angry and hit the glass, first with the left fore-hand and then with the left hind-hand, and continued to do so with such violence that we were finally compelled to break the spell. While eating some fruit, he saw himself in the glass, and ran away preciptately, that he might keep possession of his morsel." A colored India-rubber ball that emitted a musical note when squeezed was examined with timid curiosity at first. "At length, he took the ball in his hands, not seeming afraid, and tried by gentle pressure, in imperfect imitation of what he had seen me do, to evoke its note. Failing in this, he commenced to hit it forcibly with the knuckles, and grinned with pleasure when the sound was produced. He then hit it violently, drawing the upper lip over the upper row of teeth, looking as if delighted in the exercise of his powers. He was allowed to see a piece of fruit put in a tin box or canister, and the latter closed by a firm adjustment of the lid. He very quickly applied the teeth, not the fingers, to remove the lid, and, having succeeded in doing so, extracted the fruit. But, seeing a similar cover on the opposite end of the canister, the previous association of contiguity between an adjusted cover and inclosed fruit forced him unreasoningly to remove this cover also."

The New England Meteorological Society.—The New England Meteorological Society was formed in June, 1884, to advance the study of atmospheric phenomena in New England, and to collect and diffuse information in meteorology. Its meetings are held on the third Tuesdays of October, January, and April, at places designated for each meeting. It publishes a monthly bulletin, containing a summary of the meteorological conditions of the preceding month, with other items of interest, which is supplied to members. Observations are welcomed from every one, and circulars and blanks to aid in making them are sent to those who desire them. The society is making arrangements for the display of daily weather-signals with railroads, postmasters, town authorities, and others, and contemplates the institution of investigations on the subject of ozone in its relations with epidemic disease. For carrying out its work, it relies wholly on the fees of membership, three dollars a year each member. Hence all interested in its work are invited to apply for membership to W. S. Davis, Secretary, Cambridge, Massachusetts.

Heavy Ordnance for National Defense.—In a pamphlet on "Heavy Ordnance for National Defense," Lieutenant W. H. Jaques, of the United States Navy, shows that we are in pressing need of guns to make our fortifications of value; that the most practicable type of the guns that are required is that represented by the system of Mr. J. Vavasseur, of London; and that there are no establishments in the United States possessing sufficient plant and experience to manufacture them on the scale that is demanded. In answering the question, What is the best method of supply of such guns, he shows, by cogent reasons, that the Government can not depend on foreign supply or private industries, and should not rely on its own factories alone. That which suggests itself to

him as the most feasible way for securing a provision of heavy ordnance is, for the Government to make arrangements for obtaining a supply of tempered steel from private industries, and provide for the fabrication of the guns—that is, for the machining and assembling of the parts, and the sighting of the guns—in its own factories, of which there should be two, one for the army and one for the navy. For this purpose appropriations should be made immediately for the purchase of steel, so that manufacturers may prepare to furnish it.

Scorpion-Lore verified.—A correspondent of "Land and Water," who has lived in Jamaica, has verified some of the curious stories that are told about scorpions. Having found one of these creatures among some old papers, he tried the experiment of blowing upon it, to test the verity of the tradition that a scorpion will not move under such circumstances. Somewhat to the experimenter's astonishment, the animal stopped at once, and flattened himself close to the paper on which he had been running, and would not move even when he was prodded with a pencil, or the paper to which he clung was shaken. As soon as the blowing was discontinued, the scorpion advanced cautiously, only to stop again at the slightest breath. Another experiment was made with regard to the readiness of scorpions to sting themselves to death. A circle of burning sticks was laid three yards in diameter, and the scorpion was placed in the center of it. The fire was not so hot but that the temperature was endurable within a few inches of it, and the center of the circle was cool. The scorpion made several desperate efforts to escape, and finding it could not, "retired almost into the exact center of the circle, and there in a tragic manner raised his tail till the sting or spur was close to his head, gave himself two deliberate prods in the back of his neck, and thus miserably perished by his own hand." An accidental observation enabled the writer to verify the story that the young of scorpions live upon the back of their mother. While he was playing billiards, something fell from the roof of the building upon the table. It proved to be a female scorpion, and from it ran away in every direction a number of perfectly formed scorpions, about a quarter of an inch long, of which thirty-eight were killed. The mother was in the throes of death, her body having been entirely eaten away by the brood. The negro attendant of the billiard-room said that the young scorpions always lived thus at the expense of their mother's life.

Local Variations in Thermometers.—Mr. H. A. Paul has called attention to discrepancies in the observations of temperatures which can not be covered by the ordinary precautions in the exposure and reading of thermometers, nor even by those more carefully devised ones recommended by Mr. H. A. Hazen, of the Signal-Service Office, in his recent paper on "Thermometer Exposure." According to Professor T. C. Mendenhall, of the Ohio State Weather Service, "the means of the thermometrical readings of the twenty State Service stations on the nights of the 21st and 25th of January, 1884, differed by respectively 12·4° and 14·7° Fahr. from those of the four Signal-Service stations. At Columbus a difference of 27° appeared between the reading of a thermometer on the north side of a stone building, and that of the State Service instrument in an open lot three miles distant. This circumstance indicates that the true minimum can not be got in a city or to the leeward of it when a moderate breeze is blowing. It may be questioned also whether exposure near the ground, where the conditions must vary with the local character of the surface, can be relied upon as a measure of the average state of the atmosphere for a few hundred or a few thousand feet overhead. Hence a plan of exposure on high, open scaffoldings would be highly desirable. At any rate, meteorological stations, especially those of the Signal Service, which is engaged in predicting the weather conditions for large areas, will have to be moved into the country, and probably to moderately elevated points, before the best results can be obtained."

The Great Bore of the Amazon.—Mr. John C. Branner, formerly of the Imperial Geological Commission of Brazil, has published a paper on the pororóca, or bore, of the Amazon, a manifestation of force peculiar to the northern division of the mouth of

the great river, of which the inhabitants of the adjacent country stand in extreme terror. It was not his privilege to witness an exhibition of the phenomenon, although he much wished to do so, while the people with whom he was staying desired that he or any one else should not, but he observed some of its effects and had the scene described to him. The most impressive manifestations of the force of the wave are near the mouth of the Araguary River. An eye-witness of one of the appearances of the pororóca, at that place, one of a party of soldiers, related that "shortly after the tide had stopped running out they saw something coming toward them from the ocean in a long white line, which grew bigger and whiter as it approached. Then there was a sound like the rumbling of distant thunder, which grew louder and louder as the white line came nearer, until it seemed as if the whole ocean had risen up, and was coming charging and thundering down on them, boiling over the edge of this pile of water like an endless cataract, from four to seven metres high, that spread across the whole eastern horizon. This was the pororóca! When they saw it coming, the crew became utterly demoralized, and fell to crying and praying in the bottom of the boat, expecting that it would certainly be dashed to pieces, and they themselves be drowned. The pilot, however, had the presence of mind to heave anchor before the wall of waters struck them; and, when it did strike, they were first pitched violently forward, and then lifted, and left rolling and tossing like a cork on the foaming sea it left behind, the boat nearly filled with water. But their trouble was not yet ended; for, before they had emptied the boat, two other such seas came down on them at short intervals, tossing them in the same manner, and finally leaving them within a stone's-throw of the river-bank, when another such wave would have dashed them on the shore. They had been anchored near the middle of the stream before the waves struck them, and the stream at this place is several miles wide." The signs of the devastation wrought upon the land by this gigantic wave are very impressive. Great trees, dense tropical forests, "uprooted, torn, and swept away like chaff"—for the most powerful roots of the largest trees can not withstand its rush; the destruction of the banks for some distance inland; and the formation of new land in places, are among the signs of its ravages. The pororóca is an accompaniment of the spring tides, and is due to the resistance offered to the tidal waves by the sand-bars and narrow channels which they have to meet. Its effects are most marked in the northern channels of the mouth of the Amazon, while little is known of it in the southern channels.

Drift-Copper in Iowa.—Mr. A. R. Fulton, president, read a paper, before a recent meeting of the Des Moines Academy of Science, on the pieces of native copper that occasionally occur in the drift of Iowa. He named several specimens that had been found in different parts of the State, varying from ten ounces to thirty pounds in weight, all identical in appearance with the native copper of the Lake Superior district. They had doubtless been brought down from there by glacial action, and this made it probable that the glacial current had some time during the Ice age flowed in a southwest direction. So, pieces of lead-ore have been found in parts of the State southwest of the lead-region around Dubuque, pointing to the same supposition.

Sowing Fertilizers.—Professor Storer, of the Bussey Institution, has made some experiments to determine the quantity of given fertilizers which a man would naturally throw from his hand in sowing an acre field. Having measured off a half-acre, he employed a careful laborer, accustomed to such work, to scatter the fertilizers over the soil, directing him to sow them as if he were sowing grain thickly. Doubling the amount actually sowed on the half-acre to adapt the proportion to the standard of a whole acre, the quantities sown were, to the acre: of nitrate of soda, 214 pounds; of muriate of potash, 173 pounds; of superphosphate of lime, 173 pounds; of blood, bone, and meat-dust fertilizer, 124 pounds. All of the substances were quite finely powdered up, except the nitrate of soda. The blood, bone, and meat-dust fertilizer weighed 50 pounds to the bushel; the superphosphate of soda, 68 pounds; the muriate of soda, 69 pounds; and the nitrate of soda, 88 pounds. The experiment was repeated with

a student of the institution, "an exceptionally intelligent American of one-and-twenty years," without much experience in that work, to do the sowing, and who moved as rapidly as the other man had moved deliberately. He scattered nitrate of soda at the rate of 194 pounds to the acre, and muriate of potash at the rate of 116 pounds. The laborer's work may be regarded as a useful indication of what would actually happen in case the specified fertilizers, says Professor Storer, were sown by hand. It will be noticed that the figures of the table agree very well with certain rules or statements current in agricultural journals, concerning the amounts of saline manures proper to be applied in practice; and it may well be true that some of these rules were originally based upon observations of the amounts of material that a man could conveniently scatter.

Suicide a Product of Fast Modern Life.—The "Lancet," noticing the increased prominence which suicides have appeared to assume in recent years, and believing that a large proportion of those crimes are the deliberate, conscious acts of persons overburdened with the cares of life or dreading some terror, attributes the increase to the fast rate of modern life. Boys and girls, it says, "are men and women in their acquaintance with and experiences of life and its so-called pleasures and sorrows, at an age when our grandparents were innocent children in the nursery. . . . Life is played out before its meridian is reached, or the burden of responsibility is thrust upon the consciousness at a period when the mind can not in the nature of things be competent to cope with its weight and attendant difficulties. . . . Forced education, commenced too early in life and pressed too fast, is helping to make existence increasingly difficult. . . . Hasty and too early marriages, too anxious struggles for success in life, too hazardous adventures in business enterprise, the rush of undisciplined and untrained minds into the arena of intellectual strife, and, above all, that swinging of the self-consciousness, pendulum-like, between excess in rigor of self-control and untempered license, which constitutes the inner experience of too many, are proximate causes of the break-down or agony of distress which ends in suicide. The underlying cause is impatience, social, domestic, and personal, of the period of preparation which Nature has ordained to stand on the threshold of life, but which the haste of progress treats as delay."

Oil and Earths as Food for Mice.—Professor Storer, of the Bussey Institution, has discovered that mice, when short of food, are capable of eating putty and of living upon the oil which they assimilate from it. Their capacity for feeding upon oil was demonstrated to him when one morning he found the wicks of the lamps which his workmen had left overnight in the cellar drawn and combed out, and the oil all sucked from them. Some months later he had several panes of glass set in the windows with new putty; a few days afterward he found the putty all eaten off. After making these observations, he began experimenting. He caged some mice, and, having fed them oats till they became accustomed to their new quarters, he cut down the supply of oats to just enough to keep them in good case, and gave fresh putty—ten or twelve balls, large enough to just pass through a three-eighth-inch hole to three mice. This putty, weighing twenty grammes (16·7 grammes of whiting and 3·3 grammes of oil), furnished five and a half grammes of whiting, or one third of its weight, to each animal. The whiting was passed off as an oilless dung, which became very large, white, and friable. It was relatively the same as if a man of about one hundred and fifty pounds weight were to eat and pass off fifty pounds of chalk a day! The mice would eat no more than the quantity named. If their allowance was increased, the surplus was left. To prove that it was for the sake of the oil that the putty was eaten, balls of whiting mixed with water, and of gypsum and water, were tried. They were not eaten; only a few of them were scratched enough to satisfy the mice that there was no oil in them. Red ochre when substituted for the whiting was eaten the first day, with the production of red dung, but was not eaten on the second day. It was better relished when mixed with whiting, but the mice soon tired of it in that shape. Yellow ochre was hardly more ac-

ceptable than red. Mixtures of linseed-oil and gypsum were eaten freely, but not so freely as the whiting mixture. Carbonate of baryta proved to be poisonous to the animals, but the poison seemed to be neutralized when carbonate of lime was mixed with it. Carbonate of lead seemed to act as a poison, but not so deadly, provided it was mixed with whiting, as it might have been supposed to be. Clay was not appreciated by the mice, but was eaten when mixed with whiting. Experiments with various results were also tried with sulphate of baryta, silica, carbonate and oxide of zinc (both eventually producing death), slaked lime (of which only one of the mice would eat enough to kill him), and whiting and sirup, which was eaten freely. Similar experiments were tried on rats, with similar results.

Rainfall as affected by Wind. — The proper construction and location of rain-gauges to secure measurements agreeing with the average rainfall on the surrounding district has been a much-discussed problem. In 1766 Dr. Heberden observed that gauges on the ground collect generally a larger quantity of rain than gauges on the sides and roofs of buildings. As a summary of facts since learned, G. E. Curtis, in "Signal-Service Notes," No. 16, quotes the following from an article published by Symons in 1878: "The greater part of the decrease is due to wind. The stronger the wind, the greater the decrease with elevation. The less the diameter of the elevated gauge, the less will it indicate. A gauge on the leeward side of a tower may collect as much rain as one on the ground. A gauge in the middle of a large roof may, notwithstanding its height, collect very nearly the same as one upon the ground." In the following year Symons further stated that "there is no evidence of any difference between the fall of rain at various heights from sixty to two hundred and sixty feet above the ground." How the variation in the vicinity of buildings can depend on the wind was explained in 1861 by W. S. Jevons, who said that a stream of air meeting an obstacle leaps over it, flowing with increased velocity above it, as a river flows fastest through narrows. When two equal drops of rain fall into a current of air at points where the velocity is not the same, one drop will either approach toward or recede from the other, and the quantity of rain falling on the space beneath will be increased or diminished. The large rainfall registered at the Signal-Service station on Mount Washington has recently been specially investigated. Four extra gauges, three inches in diameter, were set up seventy-five feet respectively north, east, south, and west from the station-gauge. The observations of thirteen months showed that precipitation varies materially within one or two hundred feet. It was found also that the windward gauges generally recorded the least rain, the central gauges more, and the leeward gauges the most. Hence it is concluded that the wind affects the distribution of rain on the summit of Mount Washington in the same way as on the tops of buildings. During this period the station-gauge, which is eight inches in diameter, was found to give larger readings than the others, and a three-inch gauge was set up near the large one for comparison under the same conditions. The conclusion reached was that the discrepancy was due to insufficient collection by the smaller gauge, and varied as the square of the wind's velocity. European observers have noticed no such differences between the measurements of three-inch gauges and larger sizes, but their observations were made when the velocity of the wind did not exceed twenty miles an hour, while on Mount Washington it reached seventy-five miles an hour.

The Food of Animals.—The question whether the distinction between herbivorous and carnivorous animals is as clear as it has been supposed to be is discussed in the "Field Naturalist" and the "Journal of Science." The prevailing theory is that the primary animal life was herbivorous; and this must have been the case with the earliest and lowest forms, which had nothing but plants on which to feed; but among vertebrates, and especially among mammalia, the earliest forms seem to have been zoöphagous or animal-eating. Among fishes, amphibians, and reptiles, even in the earlier geological epochs, the vegetable feeders are found in a minority. The earliest fossil

birds were plainly fitted for a predatory life; and the lowest and earliest forms among mammals are decidedly zoöphagous. It may even be permissible to ask if among mammals the purely plant-eating forms have not been developed from a zoöphagous or at least from an omnivorous stock. The only large group which contains no zoöphagous or omnivorous members, that of the ruminants, is characterized by its complicated and highly specialized digestive organs, "evidently modified from the normal mammalian type, so as to be adapted to a purely vegetable diet." Numerous animals are zoöphagous at one period of their lives and plant-eating at another, and experience a natural and normal change. Thus all mammals begin life as milk-eaters. Likewise all birds begin with a diet of insects and worms or of half-digested food disgorged from the crop of their parents. Changes arising from scarcity of food, or from caprice, are also on record. Domesticated dogs and cats often partake of vegetable matter. Among wild animals the change in diet when it occurs is most generally from vegetable to animal. Curiously, when any species has adopted a new diet, it shows a great disinclination to return to its former food. The majority of warm-blooded animals may, however, be regarded as omnivorous, in so far that they consume both animal and vegetable food. Apes and monkeys, generally classed with vegetarians, "never omit an opportunity of robbing a bird's nest, and feed with avidity upon a great variety of insects." The bears and their allies, except the so-called polar bear, carnivores, seem to prefer fruits, roots, honey, insects, and even grain before it is ripened and hardened. "There is no satisfactory evidence that any of the cats in a wild state will consume vegetable matter, but at least two groups of the *Canidæ*—the foxes and the jackals—are not averse to fruit." Among the rodents an omnivorous character is becoming more and more fully established. The *Solidungula*, or horse kind, and the ruminants are, so far as is known, strictly vegetarians; but the other sub-order of the *Ungulata*, that of the pachyderms, includes the swine, the most typically omnivorous animals. Among the birds, the number of purely plant-eating species is relatively smaller, that of the exclusively zoöphagous larger, and that of the forms recognized as omnivorous is increasing as our knowledge of their habits extends. Thus the animal-eating and plant-eating forms of animal life are not separated from each other by any sharply marked characters, but are connected by a multitude of creatures intermediate in their organization, and consequently adapted for a mixed diet.

Health and Density of Population.—Professor de Chaumont recently illustrated the influence of density of population on health, by comparing London and Paris. In Paris every individual had an area of about forty square metres, while in London he had eighty. The result of the difference was clearly shown, not only in the lower death-rate in a larger population, but in the character of the diseases, while some diseases—scarlet fever, for instance—were more severe in London than on the Continent; others, such as typhoid fever and diphtheria, were much more common and fatal in the large cities of the Continent than they were in England. In London, the streets were filthy and the sewers abominable, but the houses were the perfection of cleanliness; whereas, in Paris, one might give a dinner-party in the sewers, and the streets were perfectly clean, but the houses were abominably filthy. In Paris, all the filth was kept in or under the houses, while in London it was all sent away. The result was shown in the differences in the health of the two cities, particularly in diphtheria, which was described by French sanitarians as the scourge of their country, while in London it took a comparatively low position in the class of zymotic diseases.

Chinese Acupuncture.—The "North China Herald" gives some curious illustrations of the skill of Chinese doctors in cauterization and acupuncture. With two copper coins as his only tools a Mantchoo peasant produced an effectual counter-irritation in a case of slight sunstroke. Acupuncture is performed first in the hollow of the elbow of each arm, and is regarded as successful if blood flows from the wound. If the blood does not appear, the case is regarded as grave, and the operation is repeated in the abdomen, with drawing back and forth of the needle. If the patient shows signs of

pain, or blood is drawn, a poultice is applied, and recovery is regarded as almost certain. If the blood does not flow, or the patient does not suffer, the case is given up. A case is quoted in which a young Chinese was instantly relieved of the cramp of cholera by this process. The Chinese explanation of their treatment is that, when the blood is in the poisoned condition which induces the choleraic symptoms, it becomes thick and accumulates in certain parts of the body, from which it must be withdrawn.

Development of Zuni Civilization.—Mr. F. H. Cushing explained before the British Association his theory of the manner in which the present civilization of the Zuñis rose by a genuine process of self-development from a low condition of barbarism, in which he finds every reason to believe those Indians originally existed. The brush-covered wigwam in which they first dwelt gave way to a small building of lava-stone, or a cliff-dwelling, and that to the pueblo-house, which is both cliff and dwelling in one. Their earliest vessels were gourds. They incased them in wicker-work for safer transportation; then took the wicker-work alone, and had a basket; then plastered the basket with clay to make it tight, and got the idea of a pottery-vessel. The first ornamentation of their pottery was derived from the imitation of this wicker-work frame. And all this took only a few centuries—nothing near the numerous cycles of ages which some anthropologists imagine it must have taken man to reach a civilized state.

Family Relations of the Muata Yanvo.—Dr. Pogge and Max Buchner have described the people of the Muata Yanvo, or Matianvo of Livingstone, as, although fetich-worshipers, practicing circumcision, a "fine warlike race, unhappily addicted to slave-hunting, though far in advance of some neighboring tribes, and living under feudal institutions." "Among many peculiar customs," says General Lefroy, "is one which invests one of the king's half-sisters, under the designation of the Lukokescha, with the second authority in the kingdom. She is forbidden to marry, but permitted a sort of morganatic alliance with a slave, any offspring being ruthlessly destroyed, and, on the death of the king, she has the principal voice in determining his successor, who, however, must be selected from among the sons of the late king. . . . The extraordinary custom prevails here that a man's children do not belong to him, but to the eldest brother of their mother; and, should a child die, the father must make compensation."

Treatment for the Opium-Habit.—In his little pamphlet on this subject, Dr. Asa P. Meylert says that in all cases where unrestrained the opium *habitué* takes a larger quantity than would suffice him. The method of cure by gradual reduction alone he has tried in one case at the patient's request, but does not propose to repeat the experiment. Every reduction was attended with severe suffering. In another case, he tried to reduce gradually, using tonics to sustain the patient, but no narcotics, nor a substitute of any kind. The case was that of a woman, whose general health was good, whose will-power was unusually strong, who had not taken opium long, and was not taking a very large quantity—thirty grains of crude opium daily. It was a most favorable opportunity to try this method. The result proved that, notwithstanding the tonic treatment, she found a daily reduction of four per cent intolerable. We must therefore—if we adopt this method—consider something less than four per cent as adapted to the average patient. Suppose that the average consumption be estimated at ten grains of morphia daily—and this is a low estimate. Suppose, again, that the patient continues the drug to the one tenth grain before leaving it off altogether—and this would be a minimum limit without special treatment: to reduce from ten grains to one tenth grain, at three and one half per cent daily, would require one hundred and thirty days, or nearly four and a half months; at one per cent, four hundred and fifty-nine days, or over fifteen months. Those who know how easily the opium patient is alarmed by any sudden shock, and how naturally relief is sought from the bottle for every ill or mischance in life, need no assurance that a cure which must extend over so long a time is utterly impracticable for the average patient, outside an institution. There re-

mains but one general course of treatment which Dr. Meylert deems worthy of consideration—that by substitution. This consists in gradually reducing the drug, substituting, however, some narcotic, sedative, or soporific. He knows of no antidote which will allow the immediate cessation of morphia without pain; the best offered by the nostrum-venders being only a poor attempt at reduction and substitution. Dr. T. D. Crothers states that analyses of fourteen so-called opium antidotes showed the presence of morphia in every one.

A Blind Man's Capacities.—The death of Mr. Fawcett, the blind English statesman, has brought out a proposition to create a fund in memory of him which shall be most appropriately devoted to the furtherance of the higher education of the blind. Mr. Fawcett himself was a splendid example of what a blind man can accomplish when he sets his heart on the work he engages in; yet what he did, he did wholly without the systematic instruction which is given in some institutions for the blind. His public work was of the best, so that he was one of the most valued officers of the British Government. Besides this, he was able to ride, to walk, to skate, to row, to fish, and to climb the Alps. Though the affliction of having become blind after having seen may be considered greater than that of having been blind from birth, Mr. Fawcett was able to enjoy much from having once seen. "In his walks with his friends, he would sometimes wish to go to a place where he could have 'a view'—that is, where his companions could describe to him scenes once familiar to his sight—and more than one of those who have met him have been struck on being told by the professor (as a result of friendly inquiries from third parties as to their appearance) that he was glad to see them look so well." Thus he was able to make the recollection of what he had seen a source of pleasure to himself. Blind asylums were first founded as a kind of hospitals for incurables, without any idea of teaching anything to their inmates. But even then a few individual efforts had been made to instruct the blind. Bernouilli, more than two hundred years ago, is reported to have taught a blind girl at Geneva how to write. Saunderson and Weissenberg did the same for themselves. The attempt further to develop the idea was made in Paris exactly a hundred years ago, when Fraulein Paradies, of Vienna, who had made some efforts in the same direction, communicating with persons in France, an institution was established, in which it was proposed to give a general education to the blind, as well as to train them in special faculties.

Origin of Chinese Ancestral Worship.—According to a writer in the "North China Mail," the Chinese ancestral worship was maintained in most ancient times on the ground that the souls of the dead survive. The present, it was believed, is a part only of human existence, and men continue to be after death what they have become before it. Hence the honors accorded to men of rank in their lifetime were continued to them after death. In the course of ages, and in the vicissitudes of religious ideas, men came to believe more definitely in the possibility of communications with supernatural beings. In the twelfth century before the Christian era it was a distinct belief that the thoughts of the sages were to them a revelation from above. A few centuries subsequently we find for the first time great men transferred in the popular imagination to the sky, it being believed that their souls took up their abode in certain constellations. This was due to the fact that the ideas of immortality had taken a new shape, and that the philosophy of the times regarded the stars of heaven as the pure essences of the grosser things belonging to this world. The pure is heavenly and the gross earthly, and, therefore, that which is purest on earth ascends to the regions of the stars. At the same time hermits and other ascetics began to be credited with the power of acquiring extraordinary longevity, and the stork became the animal which the immortals preferred to ride above all others. The idea of plants having the property of conferring immunity from death soon sprang up, and the red fungus *Polypones lucidus* was regarded as the most efficacious of such plants. Its red color was among the circumstances that gave it its reputation, for at this time the five colors of Babylonian astrology had been ac-

cepted as indications of good and evil fortune. This connection of a red color with the notion of immortality through the medium of good and bad luck led to the adoption of cinnabar as the philosopher's stone, and thus to the construction of the whole system of alchemy; but the plant was regarded first.

Over-pressure in English Board-Schools.—A controversy is going on in England over the question whether or not over-pressure is exerted in the elementary schools. Much depends, in the debate, on the definition to be attached to the term over-pressure. Edith Lupton would include in it any physical or mental injury done to any child as a consequence of the carrying out of the education acts. The school-officers would require that the child should have been previously entirely healthy; but Dr. B. W. Richardson is quoted as saying that such a child in our present state of civilization does not exist. Dr. Crichton Browne has reported, after examining the London schools, that the evil in them is real, and is working injury upon the children. It is exerted by the "keeping in" after school-hours of children, usually those who are from any cause behind with their work and have to be pushed so as to be ready for the examination, and in the imposition of home-lessons. The prime motive to both these impositions is the necessity which exists for forcing backward pupils to the examination level. The very fact that these children are backward is evidence that they are not as competent to sustain the regular school-work as their brighter fellows; yet they are the ones upon whom the additional charges are laid. "The influence of that emotional excitement caused by the approach of an examination," says Dr. Browne, "is really one of the most dangerous elements in educational over-pressure," and the "examination-fever," as it has been called, "is now endemic in the metropolis." Many of the London children go to the school partially starved, through having to depend upon food which, though it may be abundant, is innutritious. They "want blood, and we offer them a little brain-polish; they ask for bread, and receive a problem; milk, and the tonic-sol-fa system is introduced to them." Some come breakfastless to school, because they must be in their places punctually, and they have no time to eat breakfast. More than a third of the children in the elementary schools of London are represented to be suffering habitually from headaches, and these come on for the most part in the latter half of the day, when the brain has become exhausted, and the pressure of work tells most seriously from it. Many are troubled with sleeplessness, generally caused by their thinking over their lessons, particularly their arithmetic-lessons. Parents frequently complain to teachers that the family are disturbed by the children talking of their lessons in their sleep. Dr. Crichton Browne believes that a considerable part of the increase in nervous and brain diseases, and neuralgia and short-sightedness, is attributable to this over-pressure. He found nothing, however, to complain of in Scotland, where the children are vigorous, well fed and clothed and taken care of. These conclusions have been scornfully contradicted by the friends of the school-boards, but Edith Lupton gives Dr. Browne a strong support by showing that even the school-inspectors had not means of ascertaining the facts at all comparable with those which he used. Thus, at Bradford, the official inspection was done at a rate which gave an average of one minute for the personal examination of each child. "Out of that time had to be taken the time required for inspecting log-book, school premises, sanitary arrangements, teachers, and pupil-teachers. The children had to be examined in reading, writing, arithmetic, sewing, English, geography, elementary science, history, drawing, and algebra. The infant department, in facts about animals, coal, gas, salt, form, color, food, plants, clothing, rain, frost, etc., etc.; modeling, geometrical drawing, weaving, planting, drill. Then there was the merit grant in all the schools, organization and discipline, intelligence and instruction, behavior of children, inspection of the exemption schedule and its authentication 'by attendance officers,'" preliminarily to which special inquiries had to be made personally. Furthermore, the inspector "had to satisfy himself that in the daily management of the school the children were being brought up in habits of punctuality,

good manners and language, cleanliness and neatness, cheerful obedience to duty, consideration and respect for others, honor and truthfulness in word and act; and not only that regard had been paid in classifying them as to their health, age, and mental capacity, but that the dull and delicate had not been at any time within the preceding year unduly pressed. And all this in five hours" for three hundred children! Miss Lupton adds instances of actual and serious over-pressure which had come under her own observation.

NOTES.

The true source of the Mississippi River has been determined, as he claims, by Captain Willard Glazier, who led an expedition in search of it in 1881, to be a lake a few miles south of Itasca Lake, and not less than three feet above it, in latitude 47° 13′ 25″. Captain Glazier's party proceeded in canoes *via* Leech Lake to Lake Itasca, and, accompanied by an old Indian guide, pushed down to the new lake, which is of considerable size, and is named after the discoverer, Lake Glazier. It is 1,578 feet above the Atlantic Ocean. The length of the Mississippi, calculated to it, is 3,184 miles. The lake has remained in obscurity so long on account of the wild condition of the country, and because it is out of the usual route of the fur-trade.

Some very satisfactory experiments in the purification by artificial aëration of the water supplied the city have been reported to the Franklin Institute, Philadelphia. On comparison with the ordinary supply, the percentage of oxygen in the aërated water was seventeen greater than before; the amount of carbonic acid was fifty-three per cent; and of total dissolved gases, sixteen per cent more. "The percentage of free oxygen," says the report, "represents the excess over and above what was required to effect the oxidation of the dissolved impurities."

Dr. John Anthony, who has had much experience in Egypt and Asia Minor, regards the difference between a dromedary and a camel as largely a matter of speed. The former bears about the same relation to the latter as the trotting-horse to the cart-horse. The dromedary is credited with trotting about twenty miles an hour, while a regular camel or burden-bearer can not be forced more than some four or five miles an hour. The Egyptian camel and the dromedary have one hump. Dr. Anthony never saw a "Bactrian" or two-humped camel till he was east of the Crimea.

Professor E. Cohn, of Breslau, has published some interesting observations made by the naturalist Leeuwenhoek on microscopic organisms in the cleanings of his teeth in 1683, or more than two hundred years ago. The observer distinguished several kinds of organisms, and described them so precisely that they would be easily recognizable. One resembled a rod—the bacillus; others, bending in curves, the bacteria; a third kind, creeping in snake-fashion, a vibrio; another kind, extremely minute, and resembling a swarm of flies rolled up in a ball, was evidently the micrococcus. Leeuwenhoek marveled that these things could live in his mouth. Two remarkable circumstances about this story are, that Leeuwenhoek used the imperfect instruments of his time with wonderful skill, and that so long a time elapsed before any progress was made in the study of bacteriology.

Dr. A. L. Frothingham, 29 Cathedral Street, Baltimore, has issued a prospectus for the "American Journal of Archæology," to be published quarterly and devoted to the study of the whole field of archæology, Oriental, classical, early Christian, mediæval, and American, and to serve as the official organ of the Archæological Institute of America. It will be illustrated. Professor Frothingham will be assisted by Professor C. L. Norton, of Harvard College, as advisory editor, and by Dr. A. Emerson, Mr. T. W. Ludlam, Professor Allen Marquand, Mr. A. R. Marsh, and Mr. C. C. Perkins, as special editors. The subscription price will be three dollars and fifty cents a year. In addition, subscriptions are invited from the friends of archæological studies for the formation of a reserve fund to meet the deficit which must occur during the first few years of the "Journal's" existence.

According to the statements of Professor Poleck, of Breslau, the "house-fungus" (*Merulius lacrymans*), which has recently become so extensively spread in Europe, is most destructive to wood that contains most mineral matter. The richer the wood in phosphates and potash compounds the more does the fungus flourish. Now, pine-wood felled in the sap contains five times as much potash and eight times as much phosphoric acid as wood felled in the winter. Hence, it is better, for the preservation of the wood, to cut the trees late in the winter season.

M. Olzewski reports that having obtained more considerable quantities of different liquefied gases, he caused liquid nitrogen to boil under a pressure of sixty millimetres at −214° C. (−353° Fahr.), when it became partly solidified. At the pressure of four millimetres, the ebullition, which took place at −225° C. (−363° Fahr.), determined the complete solidification of the

liquid. Carbonic oxide behaved in an analogous manner. Oxygen gave no sign of congelation when boiled at $-211°$ C. (about $-348°$ Fahr.).

M. Sacc announces that he has discovered a new alimentary substance in the seed of the cotton-tree, which is richer than any other known grain in nitrogenous matters. He believes that the flour of this seed is destined to take an important part in alimentation, and in the preparation of all kinds of paste, in which it acts as a substitute for milk.

M. Duclaux declares, in the French Academy of Sciences, that the vegetation of seeds is impossible in a soil wholly deprived of microbes.

An International Ornithological Congress was recently held at Vienna, at which a permanent committee was appointed to organize a system of regular observations of the movements, migrations, and habits of birds. It is intended to form a network of stations all over Europe, in which persons having a taste for such work and qualified to perform it are expected to lend their aid in forwarding the objects of the observations.

OBITUARY NOTES.

Mr. E. C. Rye, for fifteen years Librarian of the Royal Geographical Society, died February 7th, at about fifty-three years of age. He was distinguished in science as a student of *Coleoptera* and author of a book on "British Beetles"; he was also for eleven years editor of the "Zoölogical Record."

Professor Henry Lawrence Eustis, Dean of the Harvard Scientific School, died in Cambridge, Mass., January 11th, aged sixty-six years. He became Professor of Engineering in the Scientific School in 1849. He was the author of technical books on engineering science.

Dr. Gwyn Jeffries, one of the most eminent of European conchologists, died, January 24th, of apoplexy. He was born in Swansea in 1809, began his conchological studies by collecting shells on the beach when he was ten years old, and produced his first scientific paper in 1828. He was a pioneer in deep-sea research, having begun dredgings on his own account; he afterward participated in expeditions with Dr. Carpenter and Professor Wyville Thomson; subsequently pursuing similar researches in Davis Strait; and was a promoter of the Challenger Expedition. At the Montreal meeting of the British Association, he read a paper on the relations of species inhabiting the opposite coasts of the Atlantic. He was an active member of the British Association, and a member of numerous other learned societies.

Mr. Richard Atkinson Peacock, an English engineer and geologist, whose special study was the investigation of the causes of volcanoes and of subsidences of the earth, died in London, February 2d, in the seventy-fourth year of his age. He was the author of books on "What is and What is not the Cause of Activity in Earthquakes and Volcanoes," "On Steam as the Motive Power in Earthquakes and Volcanoes," and on "Physical and Historical Evidences of Vast Sinkings of Land on the North and West Coasts of France and Southwestern Coasts of England."

The death is announced of Professor Lucä, the Frankfort anatomist and anthropologist.

Mr. J. Turnbull Thomson, Surveyor-General of New Zealand, died on the 14th of October, aged sixty-three years. He was born in Northumberland, and went to New Zealand in 1856, after having spent seventeen years in the East India Company's service. He organized the New Zealand system of land-survey, which is very exact, and under which land-holders are secure as to their boundaries. He had been a Fellow of the Royal Geographical Society since 1848, to whose "Proceedings" he contributed a paper on the "Survey of the Province of Otago." He was author of several books on social and economical subjects, and papers on scientific and practical topics, many of which were published in the "Transactions" of the New Zealand Institute.

Dr. E. H. von Baumhauer, Perpetual Secretary of the Scientific Society of Holland, and formerly Professor of Chemistry in Amsterdam, died in Haarlem, January 18th, at the age of sixty-four years. He was most interested on the practical side of science, in which he introduced many useful applications, and was also known for his researches on meteorites, and for his universal meteorograph. He was active in measures for facilitating international exchanges of books, on a plan like that which is pursued at the Smithsonian Institution. He was a member of the Netherlands Commission at our Centennial Exhibition in 1876.

M. C. H. L. Dupuy de Lôme, an eminent French naval engineer, died in Paris, February 1st, aged sixty-eight years. His name has been identified with works of naval construction in his native country since 1850. During the siege of Paris by the Germans, he directed the experiments by which it was sought to make balloons useful in the defense of the city, and since that time he has been interested and engaged in seeking solutions of the question of the propulsion of balloons.

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